Read Elements 99 and 100

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Mystery of Elements 99 and 100 1
British Scientists Warn of Radiation 10
Materials Testing Reactor Shown 13
Back Cover Picture:
Materials Testing Reactor controls 14
Uranium From Phosphate Slime 15
Negative Pressure Solves Riddle 17
Chemicals That Rout Diseases 19
Universal Diet No. 1 22
Water as a Substance 23
For the Home Lab:
Organic Reactions: Nitration 25
Phosphorus Nerve Gases 27
First Aid For Nerve Gas 29
Clue to Smog Deaths 31
Leaf Damage Records Smog 33
Frozen Desserts Confuse Law 35
Ten Kinds of Tastes 37
Extenders For Insecticides 39
Sintered Solids 41
Laminated Plastic For Planes 43
Inventions in Chemical Fields 44
Book Condensations 47
Proudly Presented 48

Editorial:
It's Elemental
Inside Front Cover

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It's Elemental

THE MOST fundamental things in the universe are those that we practically never see, or can see. We are told that there are electrons (particles of electricity). There are protons, best known as the hearts of the ordinary hydrogen atom. There are neutrons, the particle that sets off the atomic bomb, and is produced by it in such profusion. These are only the most common and stable of more than a score of sub-atomic particles. All are eternally beyond the reach of human vision, and all unknowable, except through their effects.

Up the ladder of size, from within the atom, are the atoms themselves, actually approaching a thousand in variety of isotopes. Many chemistry books still on library shelves will end the Periodic Table with 92, uranium, and these pre-World War II books have missing elements in their Tables.

Now there are a hundred chemical elements, all discovered. Some of them were found through the actual synthesis of elements by means of atom smashers — tools that would make any alchemist green with envy. These elements are built of protons, neutrons and electrons, and some of them have a dozen or more varieties, called isotopes.

The discovery of the elements, particularly in this atomic age, is one of the most fascinating chapters of human progress. This is a continued story, the latest spisode of which is told in the leading article in this issue of CHEMISTRY.

The elements, particularly the ones that are stable and not constantly disintegrating themselves by natural or artificial radioactivity, are the building blocks of the material, living and inanimate, which we use and see every day. Very seldom do we see a pure element, although diamond is pure carbon and copper and aluminum are used in their elemental form. Most of the stuff about us consists of great aggregations of molecules composed of one or more elements.

Chemistry has such tremendous scope because these materials and their properties are so important to our material and intellectual existence.

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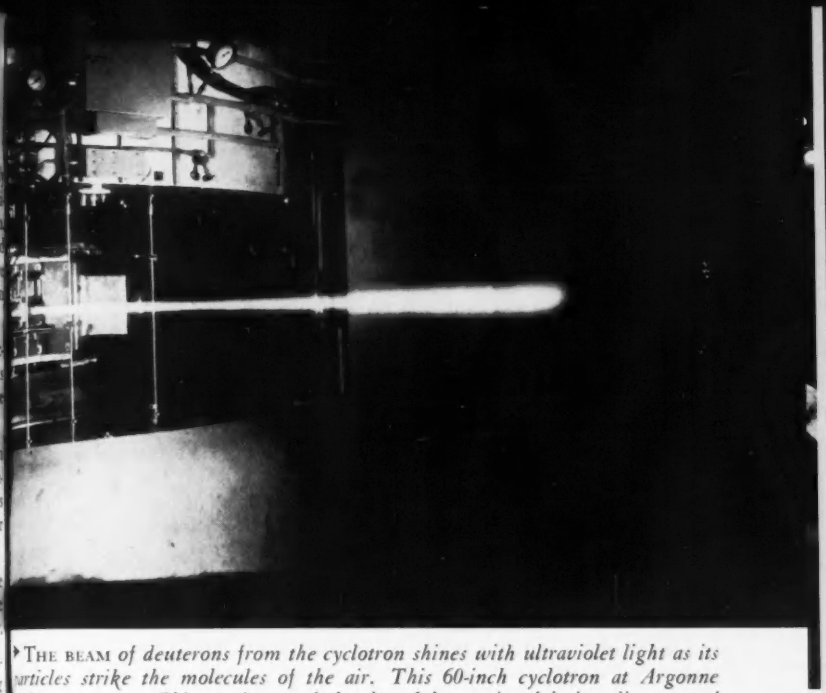

THE BEAM *of deuterons from the cyclotron shines with ultraviolet light as its particles strike the molecules of the air. This 60-inch cyclotron at Argonne Laboratory, near Chicago, is one of the three laboratories claiming discovery of the latest man-made elements.*

Mystery of Elements 99 and 100

by HELEN M. DAVIS

THE NUMBER of elemental building blocks of the universe is an even and rounded off one hundred. There are that many chemical elements that have been discovered or, in a few cases, made and discovered.

The last two elements 99 and 100, still unchristened, were announced this year. The elements that are beyond uranium, No. 92, have appeared in the atomic age, in the last 15 years. One of them, No. 94, named plutonium, shares with uranium the extreme importance of being atomic bomb material.

Yet the chemists are confident that there will be still more elements synthesized and discovered in that way. There are places being left on the periodic table charts for elements 101, 102, 103 and 104. There are even hopeful blank spaces for more elements up to at least No. 118.

The table of chemical elements will probably end with number 110, although it is theoretically possible to project the synthesis of elements be-

XUM

yond this number. The reason is that as the elements become heavier and heavier, they begin spontaneously splitting themselves up so that it becomes a race between their fleet existence and the time that it takes to identify them and prove their existence.

Dr. Seaborg speaking at the National Association of Science Writers Founders' Day dinner explained the significance of this fissioning that will cause, he predicted, elements beyond 110 to disappear as fast as they are put together. Dr. Seaborg "guessed" that three or four more elements beyond the present record element No. 100 will be added to the list in the next few years. It may be that five or six more will be added.

Naming the new elements is always exciting. It would be logical to name the present top of the list, No. 100, "centium." Cent- is Latin for a hundred, and ium is the conventional ending for metals. The prerogative of christening new elements is with the discoverer. The unresolved question of what group did discover 99 and 100 leaves in doubt that right of naming them.

While element 110 is tops in probable earthly elements, there is always the possibility that some place else in the universe, as in some strange superheavy star, conditions may be such that heavier elements can exist. This is a speculation.

Credit for discovery of elements 99 and 100 is being claimed by at least four groups of scientists, three in America and one in Sweden. Decision about which group found them first is hampered because some of the evidence has not yet been cleared for publication.

In its 16th semi-annual report, covering the period January-June 1954, the Atomic Energy Commission states that element 99 was produced in the 60-inch cyclotron at the University of California Radiation Laboratory, but that, "prior to the production of element 99 by cyclotron bombardment, this element had been discovered as a result of research work, not yet classified, at Argonne National Laboratory, Los Alamos Scientific Laboratory and the University of California Radiation Laboratory.

"Production and identification of both elements 99 and 100 was made in another fashion," the report continues, "by groups working independently at the Argonne National Laboratory and UCRL. The laboratories reported that the elements were produced by subjecting plutonium to neutron bombardment in the Materials Testing Reactor."

Neutron bombardment, whether in a cyclotron or in an atomic pile, is the classic method for transmuting one element into another. It was used in the production of neptunium and plutonium, the first man-made elements, in the research which led to manufacture of the first atomic bombs.

Since then the general principles of transmutation have been worked out. Nuclear scientists can calculate the kind of atomic projectile and the amount of energy in electron volts necessary to effect a certain kind of rearrangement in a given atom. They can predict the nature of the resulting element, whether its radioactive life will be short or long, and the probable reaction by which it will disintegrate.

Each element in turn is made by incorporating into its nucleus one

▸ THIS *"universal coffin" at the Materials Testing Reactor, Arco, Idaho, was the birthplace of the new elements 99 and 100, as reported to date. Both groups of scientists, at the Radiation Laboratory, Berkely, Calif., and at the Argonne Laboratory, Chicago, used transuranium material irradiated in this new experimental reactor.*

proton more than is in the next lighter one. But there are several ways of accomplishing this result. A step may be skipped by bombarding a nucleus with deuterium, which has two protons, instead of with hydrogen, which has a single one. Neutrons, which add weight to the nucleus, may be forced in until the atomic structure becomes unbalanced. Internal rearrangement may then throw out a negative beta particle and change the nature of the original element into that of the next heavier one.

A whole series of isotopes has been built up for each new man-made element, as well as for the naturally occurring ones. Isotopes of the same elements are alike in chemical properties, but differ from one another by the number of weight-determining neutrons they hold.

One problem in the building up of heavier and heavier elements beyond uranium comes from their radioactivity. Disintegrating from the instant they are formed, it is hard to accumulate enough of their atoms to use as

XUM

material for manufacturing heavier elements.

To get around this difficulty, scientists evolved the plan of hitting a more abundant material, such as uranium or plutonium, with a bigger missile. Proceeding up the list of elements from hydrogen, the lightest, beyond deuterium and helium, which are standard nuclear ammunition, they have been experimenting with carbon, nitrogen and oxygen. Carbon is used in the form of the gas, carbon dioxide. Addition of the 6 protons of carbon to uranium's 92 would form element 98, californium, heaviest previously attained. Addition of the 6 to plutonium's 94 should produce No. 100 at one bound.

When these heavier gases are used in the cyclotron, the rate at which they are accelerated is so adjusted that its periodicity is a harmonic of the natural vibration rate of their more massive particles. By tuning to this harmonic the cyclotron can be used with less adjustment than would be necessary for the whole mass of carbon or one of the other, relatively heavy, light elements.

Beginning with the January 1, 1954, issue of the Physical Review, a series of reports began to appear which tell part of the story of the race for Element 100. A list of the articles to date is given on a later page. Both the University of California and the Argonne groups are using the new Materials Testing Reactor at Arco, Idaho, to transmute one element into a heavier one by addition of a neutron and emission of a gamma ray. They get the same group of isotopes in the medium weight range.

The isotope of element 100 claimed by the Swedish physicists at the Nobel Institute is, if their calculation is correct, a considerably lighter nuclear species than those found in America. Therefore its half-life and other properties will be an interesting contrast to those of the heavier kinds formed in the pile.

Aside from mankind's illogical satisfaction with the number 100, there is no extraordinary importance in the discovery of this particular element. The one chemists are really anxious to see is No. 104. This will settle a theoretical bet, and may affect the future course of atomic chemistry.

A hundred years ago comprehension of the chemical elements was in a state of confusion. There were too many elements to seem convincing if they were the ultimate particles of matter. Some groups of them were too much alike not to be evidence of some relationship in structure. Yet every logical effort to put together a scheme that would show a relationship among all the elements then known had ended in failure.

It was at this point that the great bet on atomic structure began. In 1869 Professor Dmitri Mendeleeff of the University of St. Petersburg was so sure that the irregular evidence for some kind of regularity in the properties of the elements was a key to the difficulty that he drew up the first Periodic Table of the elements. Where the known regularities were thrown out of order by the atomic weights then in use, he stated that those weights must be wrong. Where there were no elements to show expected resemblances in certain parts of the table, he predicted that those elements would be discovered.

After three of his predicted elements were discovered, Mendeleeff took pride in pointing out how closely the properties of the new elements corresponded to those he had foreseen by comparing the periodic shifts in values of all measurable constants from one element to the next. Thus the first bet on the accuracy of the Periodic Table was won. Although based merely on empirical relationships, without a well-formulated law behind it, it could be used to describe the kinds of elements that must appear to fill certain spaces still left blank on the chart.

The second test of the Periodic Table came just before the end of the Nineteenth Century, when five new gases were found in the atmosphere. They are so unlike all the other elements that they have no chemical properties at all. Yet they fall into place in the Table as though a place had been waiting for them all along.

By this time the relationships between most of the elements had been pretty well established, and chemists were calling their regular phases the "Periodic Law." They were beginning to take seriously a suggestion made by one Prout, many years before, that all elements are built up of hydrogen. Prout had no particular reason for this, except that hydrogen is the lightest. He merely thought this would simplify the theory. But to most chemists the idea was anathema, because the atomic masses of the elements simply would not come out as even numbers, no matter how they were juggled around.

One other difficulty plagued chemists who were trying to discover a simple general law to account for atomic structure. There was one lot of elements that seemed all to belong in one place in the Periodic Table. Because they were rare in nature and because their oxides have an earthy texture, these elements were referred to as the Rare Earths. Their discovery spread over 150 years. They became more of a headache for chemists as each new member of the series was discovered.

In contrast to the difficulty posed by the Rare Earth elements, the discovery of radium and the other radioactive elements, polonium, actinium and protactinium, filled blank spaces in the Table according to theory, in spite of their strange ability to disintegrate spontaneously. Disregarding the Rare Earth series, the Periodic Table by this time presented a regular and recognizable pattern. The chief remaining difficulty, aside from a few spaces still blank, was that the list of known elements, ending with uranium, the heaviest, broke off abruptly in the middle of one part of the pattern.

Chemists thought they could guess how the Table would end, supposing new elements heavier than uranium should be discovered. Many were sure that the anomaly of the Rare Earths would somehow be resolved by finding some way to fit them in as one element. Then the space assigned to thorium in Group IV, to protactinium in Group V, and to uranium in Group VI would be followed in Group VII by an element somewhat like manganese and in Group VIII by a set of three heavier precious metals similar to platinum.

This arrangement was wrong, but it was logical according to what was known about these heavy elements at the time. Tables showing it were

printed in chemistry textbooks for many years. The error was detected and the problems of atomic structure were solved by the research that led to production of the atomic bomb.

One trouble was that, although the neighboring elements in the Table had been discovered and named, not too much was known about most of them. It was difficult to be sure that one element belongs to the same family as another when the family characteristics were not too well defined. Thorium was supposed to be like titanium, zirconium and the recently discovered hafnium, but those elements had not much use and very little study. Uranium was supposed to be like manganese and two intermediate elements whose very existence was problematical.

As research on the radioactive transformations of uranium progressed, many mysteries about the elements began to be cleared up. Scientists learned that they are indeed made up of hydrogen, but in an unexpected way. The puzzle about the fractions in the atomic weights was solved by the discovery that there are isotopes of the same element which have different atomic weights. Mixtures of different amounts of these isotopes are responsible for the fractions. The differences between the isotopes is due to neutrons as well as protons (hydrogen hearts) in the nucleus.

As the mechanism of radioactive disintegrations became clearer, the once-discredited transmutation of elements became a reality, and the laws governing the process became well enough known so that reactions could be brought about that would yield the expected atomic forms

Reactions were discovered which would start with one element and produce the next heavier one. It thus became possible to try the creation of unknown elements heavier than uranium. The experiment was successful. Eight elements now exist beyond the heaviest occurring in nature.

As chemists have explored the properties revealed by these new man-made elements, those who have become most familiar with their compounds have become increasingly sure that elements 90-103 constitute a new series corresponding to the Rare Earths. Dr. Glenn T. Seaborg and his group of chemists at the Radiation Laboratory of the University of California, who have probably had more experience with the artificially produced elements than any other chemical research group, believe the two series correspond element for element. They prefer the name "Lanthanide Series" for the Rare Earths, following lanthanum, and "Actinide Series" for the still incomplete list, following actinium, which begins with thorium.

The properties of the new elements show individualities, yet are much like those of the other Actinides. In this they resemble the likenesses of the Lanthanides to one another.

But some other chemists, especially abroad, interpret the data differently, and have other theories about where the Periodic Table goes from here.

Here lies the essential drama in the race for newer and heavier elements. If three more elements can be created, the Actinide series should be complete. The mere production of these elements, out of material that is disintegrating almost as fast as it is formed, is a challenge. But, beyond

No. 103, comes the pay-off. If No. 104 proves to have properties and form compounds that are more like those of hafnium, zirconium and titanium than they are like those of the other man-made elements, the chemists who are betting on the regularity of the Periodic Table will have won. If this proves not to be the case, a new mystery will be added to atomic theory.

With recovery of many new isotopes of lighter elements from the fission products of uranium, all the known blank spaces in the Periodic Table have now been filled. The properties of those previously unknown have proved to be in general what was expected.

If actual wagers were being made, the betting would probably run in favor of No. 104 swinging into line beside hafnium. In that case, No. 111 would be expected to be super-gold. The pattern will end with No. 118 as the next inert gas with no chemical properties. Some physicists believe that with this element the nucleus would become so heavy that it would collapse. Those who believe this think they can detect matter of this kind in some of the stars. At this point the chemists are willing to turn the argument over to the astronomers.

Reporting Elements 99 and 100

References to articles which appeared in The Physical Review

Jan. 1, 1954—Vol. 93, No. 1, p. 256. The Acceleration of Nitrogen-14 (+6) Ions in a 60-Inch Cyclotron. G. Bernard Rossi, William B. Jones, Jack M. Hollander, and Joseph G. Hamilton. *Crocker Laboratory, Radiation Laboratory, and Division of Medical Physics, University of California, Berkeley, California.* (Received November 25, 1953).

Reports study of the acceleration of heavy ions, particularly $C^{12}(+6)$, $C^{13}(+6)$, $Ne^{20}(+9)$, $Be^{9}(+4)$, $N^{14}(+6)$, $C^{12}(+5)$, $C^{13}(+5)$, and $O^{16}(+6)$.

Jan. 1, 1954—Vol. 93, No. 1, p. 257. Reaction of U^{238} with Cyclotron-Produced Nitrogen Ions. Albert Ghioroso, G. Bernard Rossi, Bernard G. Harvey, and Stanley G. Thompson. *Radiation Laboratory and Department of Chemistry, University of California, Berkeley, California.* (Received November 25, 1953).

"The acceleration of $N^{14}(+6)$ ions with the Berkeley Crocker Laboratory 60-inch cyclotron has made it possible to study nuclear reactions of these ions with U^{238}. The following transmutation products have been observed: $99^{247(?)}$, 99^{248}, Cf^{244}, Cf^{246}, $Cf^{247(?)}$, Cf^{248}, Bk^{243}, and other berkelium isotopes not yet identified. . . . The nuclides Cf^{244}, Cf^{246}, Cf^{248}, Bk^{243}, Bk^{245} have previously been observed in this laboratory.

"There is unpublished information relevant to element 99 at the University of California, Argonne National Laboratory, and Los Alamos Scientific Laboratory. Until this information is published the question of the first preparation should not be prejudged on the basis of this paper."

Feb. 15, 1954—Vol. 93, No. 4, p. 908. Transcurium Isotopes Produced in the Neutron Irradiation of Plutonium. S. G. Thompson, A. Ghioroso, B. G. Harvey, and G. R. Choppin. *Radiation Laboratory and Department of Chemistry, University of California, Berkeley, California.* (Received December 21, 1953).

Reports 99^{253} and gives a possible sequence by which it might be formed by successive neutron captures and beta decays.

"There is unpublished information relevant to element 99 at the University of California, Argonne National Laboratory, and Los Alamos Scientific Laboratory. Until this information is published, the question of the first preparation should not be prejudged on the basis of this paper or the preceding one."

March 1, 1954—Vol. 93, No. 5, p. 1129. Further Production of Transcurium Nuclides by Neutron Irradiation. Bernard G. Harvey, Stanley G. Thompson, Albert Ghioroso, and Gregory R. Choppin. *Radiation Laboratory and Department of Chemistry, University of California, Berkeley, California.* (Received January 14, 1954).

"We have succeeded in producing and chemically identifying an isotope of the element with atomic number 100 through neutron irradiation of the heavy californium isotopes in the Materials Testing Reactor . . . tentatively assigned as 100^{254}. . .

"Because of the existence of unpublished information on element 100 the question of its first preparation should not be prejudged on the basis of this paper."

March 15, 1954—Vol. 93, No. 6, p. 1428. Elements 99 and 100 from Pile-Irradiated Plutonium. M. H. Studier, P. R. Fields, H. Diamond, J. F. Mech, A. M. Friedman, P. A. Sellers, G. Pyle, C. M. Stevens, L. B. Magnusson, and J. R. Huizenga. *Argonne National Laboratory, Lemont, Illinois.* (Received January 25, 1954).

"This note describes some nuclear and chemical properties of elements 99 and 100. The transcalifornium elements were produced in a pile irradiation of plutonium in the Materials Testing Reactor. . . .

"A manuscript containing details of these experiments as well as a number of additional experiments is in preparation.

"These elements (99 and 100) have previously been discovered in other work at Argonne National Laboratory, University of California Radiation Laboratory, and Los Alamos Scientific Laboratory, not yet published."

April 1, 1954—Vol. 94, No. 1, p. 209. Additional Properties of Isotopes of Elements 99 and 100. P. R. Fields, M. H. Studier, J. F. Mech, H. Diamond, A. M. Friedman, L. B. Magnusson, and J. R. Huizenga. *Argonne National Laboratory, Lemont, Illinois.* (Received February 11, 1954).

"A short-lived alpha activity was previously reported to elute at the element-100 position. . . . This note describes the results obtained from a four-day irradiation of an element-99 fraction with californium impurity in the Materials Testing Reactor (MTR) at Arco, Idaho, to produce the following reaction: $99^{253}(n,\gamma)\ 99^{254} \xrightarrow{-\beta} 100^{254}$."

May 15, 1954—Vol. 94, No. 4, p. 1080. Nuclear Properties of Some Isotopes of Californium, Elements 99 and 100. G. R. Choppin, S. G. Thompson, A. Ghioroso, and B. G. Harvey. *Radiation Laboratory and Department of Chemistry, University of California, Berkeley, California.* (Received March 19, 1954).

"In recent publications we reported the formation of the nuclides 99^{253}, 99^{254}, and 100^{254} by intense neutron bombardment of plutonium and higher-mass nuclides. Further observations of the nuclear properties of these nuclides have now been made, using, in some cases, samples of higher activity prepared in new neutron bombardments. In addition, a 15-hour alpha-emitting isotope of element 100 has been observed in the products of the neutron bombardment of plutonium. . . ."

A summary of the properties of the isotopes of 99 and 100 follows.

July 15, 1954—Vol. 95, No. 2, p. 581. Some Pile Neutron Cross Sections of Isotopes of Americium, Berkelium, Californium, and Element 99. B. G. Harvey, H. P. Robinson, S. G. Thompson, A. Ghioroso, and G. R. Choppin. *Radiation Laboratory and Department of Chemistry, University of California, Berkeley, California.* (Received May 20, 1954).

Summary of measurements on isotopes of these elements.

July 15, 1954—Vol. 95, No. 2, p. 585. Element 100 Produced by Means of Cyclotron-Accelerated Oxygen Ions. Hugo Atterling, Wilhelm Forsling, Lennart W. Holm, Lars Melander, and Björn Åström, *Nobel Institute of Physics, Stockholm, Sweden.* (Received May 18, 1954).

"The beam of high-energy $(O^{16})^{6+}$ ions produced by the 225-cm cyclotron of this institute has been used to bombard uranium targets. An alpha activity which is ascribed to an isotope of element 100 has been found among the transmutation products formed in this way. . . . According to alpha systematics a probable mass number corresponding to these data is 250. The first positive results were obtained on February 19. The work is still in progress."

Insects compose the largest class of animals, and the Staphylinidae, or rove beetles, one of the largest single families of living things in the animal world.

Early wheat varieties as winter-hardy as rye are among possibilities from continued, long-term, co-operative research.

Vegetable oils are obtained chiefly from seeds, nuts and fruits.

Few Thousand Atomic Bursts Would End Us, Hit or Miss

British Scientists Warn of Radiation

▶ THE HUMAN RACE can not stand more than a few thousand large atomic explosions whether they hit the target or miss, Dr. E. D. Adrian, British physiologist, warned in delivering the presidential address of the British Association for the Advancement of Science meeting at Oxford.

Even if the world can survive the immense explosions and the great devastation of a major atomic war, Dr. Adrian said, we must face the possibility that repeated atomic explosions will lead to a degree of general radioactivity which no one can tolerate or escape.

A few hundred large bombs would not raise the level of radiation to the point where it would be a general danger, but the known limits of radioactive contamination observed in industry and research would soon be ignored by powerful nations which might try to win quickly whatever the risk.

Dr. Adrian is also president of Britain's famed Royal Society, master of Trinity College, Cambridge, and Nobelist in medicine and physiology in 1932. The presidential address opening the annual sessions of Britain's largest science organization is considered a major event.

Unless we are ready to give up some of our old loyalties we may be forced into a fight which might end the human race, Dr. Adrian said. Our predicament is the inevitable result of our curiosity and of the physical nature of the world we live in, but if we can make our behaviour worthy of our increased knowledge we can live safely.

The scientist, therefore, has a double responsibility. He must apply his science to learn as much as possible about the mental and physical causes which make us behave as we do, he must study human nature to prevent its failures. But he cannot wait for the discoveries which might make us act more wisely: he must take us as we are and make it his task to point out that the human race cannot stand more than a few thousand large atomic explosions whether they hit their target or miss it.

If we must continue to make war there is no kind of scientific investigation which might not be used to make it more effective.

There can be no guarantee that discoveries in the field of human conduct would be harmless. A drug or a system of education which would make us all do as we are told, a method of producing radical conversion to a new system of belief, a knowledge of new ways of rousing patriotic ardour, all these might be used with consequences almost as grim as the genetical deterioration in a radioactive world. The psychiatrist who discovers a cure for paranoia may find that he has also revealed a convenient way of producing it.

Discoveries relating to our own nature may mean a painful readjustment of our beliefs, Dr. Adrian observed. He recalled the great discussion over Darwin's theory of natural selection a hundred years ago and drew a close parallel with the impact of Freud's theories of our own generation.

The theory of unconscious forces moulding our thought has certainly diminished our stature as intelligent beings, he said. Yet the parallel still holds, for again we have recovered our equanimity. We are reconciled to the unconscious, though we may not have digested all the elaborations of psychoanalytic theory. We are no doubt less sure of ourselves, inclined to spare the rod and to put nothing in its place, but, on the whole, Freud has left us with a better understanding of human conduct and we are not down-hearted at finding it less rational than we used to suppose.

Dr. Adrian urged that there be more investigations in the field of the social sciences, even though it is difficult for those who study social activities, so enmeshed with human actions, to do controlled experiments.

Even after it is discovered what is likely to happen in a particular situation, the statesman who consults an expert may not be able to act to prevent trouble.

We may find out a great deal about the tensions which lead to war without seeing the way to keep ourselves clear of it.

Dr. Adrian is optimistic about the future, however.

We are constantly acquiring new habits and new ways of thought, he said. It does not take us very long to see the way round old quarrels. Darwin and Freud no longer trouble us. We are no doubt born with brains like those of our remote ancestors and when we are grown up we have no more native intelligence than they had, but our brains must have been so modified by what we have learnt that they are physically and chemically different, better adapted for the complex social life of our time. We have more knowledge at our disposal. If all goes well with our training the brains we have ought to be more civilized than those of our fathers and those of the next generation more civilized than ours.

Unlimited Power

➤ A SOURCE of power without limit for the world lies in the same kind of reaction that occurs in the hydrogen bomb, the fusion of light chemical elements, Sir John Cockcroft, director of Britain's Atomic Energy Establishment at Harwell, predicted at Oxford in his presidential address before the physics section of the British Association for the Advancement of Science.

Before we come to the end of our uranium fuel reserves, Sir John, a pioneer in atomic research, foresees the use of the conversion of some of the mass of hydrogen and other light elements into energy. Fusion will be turned from destruction to peaceful use, just as fission of uranium is now being applied to power plants.

Energy is the essential basis for a highly developed civilisation, Sir John said. The application of nuclear fission, wisely guided, can ensure that for a millenium ahead mankind has all the energy needed to supply his ever-growing needs.

Reviewing work on the constitution of the hearts of atoms, Sir John explained that we now have clear evidence for the building up of "shells" of protons and neutrons in nuclei leading to singularities in nuclear properties as the shells are filled.

Thus the abundance of nuclear species with closed shells is higher than normal, they have more stable isotopes, their structure of excited levels is simpler. All this can be explained by invoking the type of nuclear force, which is characteristic of strong interaction between nuclear spin and orbital momentum. The energy levels can be calculated and filled up progressively rather like atomic shells are filled up, and the shell picture emerges.

Nuclear structure differs, however, from atomic structure because there is no counterpart to the overriding strength of the nucleus in determining the electron orbits. So the collective motions of nuclei become important and they can have vibrational and rotational motions which can be checked experimentally.

New Mechanical Hands For Scientists

➤ A PAIR of mechanical hands have been created at the Argonne National Laboratory to give dexterity to atomic scientists who cannot work in dangerous radiation areas.

The mechanical slaves are controlled electronically to grasp, lift, move and twist things. They can do heavier work than their human operators, and they are not burned or killed by invisible nuclear radiation that destroys living cells in the human body.

Known as "an electronically-controlled force-reflecting manipulator," the hands are the first to receive their orders by electricity. Previous remote hands have been opened and closed, twisted and moved by levers, pulleys and cables. This arrangement requires the hands to be no farther away than 12 feet from the operator. The new electron-controlled slave can work "several hundred feet" away from its master.

Developed by Raymond C. Goertz and W. M. Thompson of the Laboratory's remote control engineering division, the hands are used with three-dimensional television so the operator can see what they are doing. In addition, a force-reflecting system is worked into the mechanical slave so that an operator can tell how hard the hands are gripping a heavy chunk of lead or a delicate glass vial.

Iron Ore Location Told by Trees

➤ WHERE a variety of tree grew gave the geologists exploring the rich iron deposits of Venezuela their clue as to the extent of the ore, it was reported by Thomas C. Oftelie of Aero Service Corp., Philadelphia, speaking to the American Society of Civil Engineers recently. Vegetation that grew only on soil produced by iron ore had a distinctive texture on the aerial photographs. This was a variety of the copei tree. The exploratory photographs piloted the scientists and engineers to the ore bodies underground.

World's Greatest Radiation Rush Shown at Idaho Atomic Lab.

Materials Testing Reactor Shown

▸THE GREATEST rush of neutrons under man's control was put on exhibition recently when the press was given a chance to see the materials testing reactor at Idaho Falls, which has been operating for over two years.

The neutrons come from the heart of an atomic reactor. Its active core is isotope-235—enriched uranium—contained in a volume only 16 by 28 inches.

With this atomic test "furnace," atomic scientists and engineers are able to subject to strenuous conditions the materials that are to be put into the atomic energy plants and atomic weapons of the future.

A sizable box-shaped building set off by itself at the National Reactor Testing Station houses the materials testing reactor. It cost $18,000,000 to build and is operated for the Atomic Energy Commission by the Phillips Petroleum Company.

Neutrons are subatomic particles without electrical charge about the same weight as the heart of the hydrogen atom. They bring about powerful reactions when they are produced in the fissioning of uranium and plutonium. It is necessary for atomic experts to know what neutrons do under controlled conditions.

The MTR displayed has a high flux of neutrons 10 to 100 times that available anywhere else. Average neutron fluxes are 200 million million thermal neutrons per square centimeter per second and 100 million million fast neutrons per square centimeter per second. Even the slow or thermal neutrons travel 5,000 miles per hour.

The reactor generates 30,000 kilowatts of heat, and it does this within a space of about two large suitcases. A flow of more than 300 gallons of water per second is needed to remove this heat.

Ordinary water is used both to moderate and to cool the reactor. Beryllium metal is used to reflect the neutrons. To confine the intense radiation, the active part of the reactor is shielded with concrete nine feet thick. No ordinary concrete aggregate is used. Instead of gravel, barytes or barium sulfate is used, because it has great density and absorbs more radiation.

In addition to being the most intense source of neutrons, the reactor probably has the most intense field of gamma radiation (which are super X-rays) available in the country.

At the same locality on the sagebrush plain in southeastern Idaho, there is also the experimental breeder reactor where methods of changing non-fissionable uranium and probably thorium into fissionable materials are being studied. Nearby also is the first version of the nuclear engine that will propel the world's first atomic submarine, the U.S.S. Nautilus. There are two aircraft nuclear propulsion programs underway, looking toward the flying of giant airplanes by atomic

XUM

power, and there is also a chemical processing plant which will work over the spent fuel of atomic reactors.

All these other atomic experimental plants were kept strictly under secrecy wraps during the newsmen's inspection.

A-Bomb Debris Confuses

➤ ATOM BOMBS are mussing up the radioactive dating of the recent past. As a consequence, ancient Indian burials unearthed during building operations near Stanford University, California, at University Village are about 3,000 years old instead of 2,000 as at first reported.

This is what happened: Charcoal from the prehistoric graves was sent to Columbia University's Lamont Geological Observatory, Palisades, N. Y., where it was sprinkled by radioactive debris from an atomic bomb in Nevada, blown skyhigh and wafted across the continent. Unaware of the contamination, Columbia reported to Prof. Bert A. Gerow of Stanford the 2,000-year age, which did not fit in well with the fact that they were in a lower earth layer than older specimens. A retest showed the older age.

Dating by radiocarbon tells age by dying out of the radio-activity of the element carbon, formed by cosmic rays out of the upper air's nitrogen and incorporated in living things through the carbon dioxide of the air.

Radioactive Hailstones

➤ RADIOACTIVE hailstones as big as tennis balls bombarded Washington, D.C., one spring day as the result of the explosion of an atomic cannon shell 29 hours earlier some 2,000 airline miles away in Nevada.

This became known through a report to the American Meteorological Society's bulletin by three U. S. Navy Hydrographic Office scientists, Gilbert Jaffe, Walter Wittmann and Charles C. Bates.

The hailstones were not very "hot" radioactively, but they registered on a Geiger counter with which their melted substance was tested.

Many children at the time of the hailstorm ate several of the hailstones like snowballs, but they suffered no ill effects.

Debris of the atomic test was carried by a low pressure system to about 40,000-foot altitude over Frenchman's Flats, Nev., and then blown at about 65 knots eastward. In Washington's vicinity strong updrafts accompanying the passage of a cold front caused large raindrops and hailstones to be recirculated several times through the contaminated air mass before they fell to earth.

The hailstones fell on May 26, 1953.

On the Back Cover

➤ CONTROLS *for the Materials Testing Reactor are on the top of the structure. The plug in the center is removed to insert new fuel elements containing highly enriched uranium. Control cabinets on opposite sides manipulate the cadmium rods which regulate the fission reaction. On a lower level are the horizontal beam holes where material to be irradiated can be inserted into the interior of the pile. Such material is put into a "universal coffin" when it is to be run into one of the beam holes, as shown on page 3.*

Potato Starch Solves Filtration Difficulty

Uranium From Phosphate Slime

▶A POTENTIALLY significant increase in uranium supplies available to the United States for both peacetime and military uses is foreshadowed by a report to the American Chemical Society.

The increase is promised by discovery of a way to tap uranium-bearing materials so difficult to process that they have been regarded as waste, according to Dr. Victor K. La Mer, professor of chemistry at Columbia University, an international authority on colloid chemistry. The essential improvement consists in accelerating the settling and filtration of these materials.

By utilizing the uranium from these very low-grade sources, Professor La Mer said, the United States can expand its domestic supplies appreciably. A substantial amount of uranium already is being obtained from higher-grade phosphate wastes, he pointed out.

A detailed account of the new processing method, which employs such simple substances as potato starch to overcome the uranium refining bottleneck, was given by Professor La Mer and two colleagues, Professor Robert H. Smellie Jr. of Trinity College, Hartford, Conn., and P. K. Lee, a research associate at Columbia, in four technical papers during the ACS meeting.

The procedure also will be valuable in solving many chemical engineering problems of industry, he predicted, for it facilitates the handling of materials which have been difficult to filter. Filtration rates have been increased as much as ten to fifteen-fold, he reported, with the aid of small amounts of potato starch and similar substances.

Professor La Mer and his associates have conducted their research on residues from Florida phosphate rock. It was recognized about four years ago that an appreciable amount of uranium is contained in phosphate rock of the type long used as a source of phosphorus for fertilizer. Several commercial firms have made important progress in extracting this uranium, but much of it still ends up in waste slimes.

The disposal of slime residues has long been a problem in the pebble phosphate industry, he pointed out. After the crude ore is treated to get phosphate for fertilizer and phosphate chemicals, the processor is left with vast amounts of a very muddy water, containing 2 to 5 per cent solids that cannot be filtered and will not settle out. He is not allowed to pour this water into streams because it would result in gross pollution.

For the time being, the phosphate companies are running the slimy residues into artificial lakes surrounding their plants and hoping the fine particles will settle. Millions of tons of slime are accumulating in Florida in this fashion. Therefore, a large source

of uranium is represented by the tremendous amounts of slimes in storage in Florida.

"Our research is the first thorough scientific investigation from the standpoint of colloid science into the problems of settling, coagulating and filtering thick suspensions of fine particles (slime) and of the relations between these problems," Dr. La Mer said. "We have been able to take an unmanageable slime and treat it so that it can be processed in conventional equipment. The rate of filtering of this material can be increased 10, 12 and sometimes 15-fold. Settling rate can be greatly increased."

A substantial improvement in the filtering characteristics of the slimes can be accomplished by the addition of small amounts of certain polyelectrolytes, Professor La Mer explained. Polyelectrolytes are chemical substances which have very long chain-like molecules made up of carbon and hydrogen, containing groups of electrically active atoms at regular intervals. From 50 to 500 parts of such substances in 1,000,000 parts of the slime are effective, he said.

The slime consists of fine particles which do not settle, but remain suspended in the water. They pack and clog the filters. A new theory to explain why polyelectrolytes are so effective in improving the filterability of slime was advanced by Professor Smellie, who said:

"The polyelectrolyte causes the slime to form almost immediately into a curdy mass. We have found that a definite amount of polyelectrolyte is required. Too much is as bad as too little, because the curds then break up into fine particles again. The polyelectrolyte molecules attach to the colloidal slime particles according to a definite pattern and build up a three-dimensional porous network.

"Potato starch is a natural polyelectrolyte and one of the most effective substances we tried. Potato starch will work where corn starch or tapioca starch won't work because potato starch contains a small amount (0.07 per cent) of phosphate. The phosphate is a key substance in the network because it combines with calcium to build up the connecting links. It is not widely known that potato starch contains phosphate and this is the first time that a possible explanation has been proposed for the effectiveness of this starch in aiding filtration.

"Monsanto Lytron 886 is one of the best synthetic polyelectrolytes we tried. This substance is chemically similar to certain soil conditioners which have recently gained prominence. Other synthetic substances, as well as some starches and gums, have been tried with varying degrees of success."

Vitamin A, the principal source of which has long been the livers of cod, halibut and sharks, is now being man-made in commercial laboratories; this synthetic vitamin A lacks a fishy taste.

The need of vitamin C to prevent scurvy has been long known but it is also necessary for the utilization of certain amino acetic acids from food.

One farm worker today produces food for 14 people.

Centrifugal Force Measures Pull of Liquid in Trees

Negative Pressure Solves Riddle

➤How CAN giant Sequoia trees pull water into their leaves 300 feet above the ground when a vacuum will not pull a column of water more than 34 feet high?

Not only have scientists explained this — they have shown that under the proper conditions water could be pulled 9,000 feet high.

One of the deans of American science, Dr. Lyman J. Briggs, presented a report on the "negative pressure" of water and other liquids in a symposium of the American Chemical Society's Division of Water, Sewage and Sanitation Chemistry at a recent meeting.

Former director of the National Bureau of Standards, wartime chief of the top-secret committee to explore the use of uranium fission, administrator and guide of numberless government and military scientific projects, co-inventor of the earth inductor compass and winner of the Medal of Merit and many other high honors for his scientific contributions, Dr. Briggs retired from his administrative duties in 1945 but has never stopped his scientific researches. He celebrated his 84th birthday this year.

Negative pressure may at first appear to be a strange notion, Dr. Briggs conceded. Under positive pressure the molecules of water are naturally crowded a little more closely together, but under negative pressure they are actually pulled a little farther apart—the liquid is stretched in all directions. This stretching is opposed by the cohesive forces between the molecules.

When these cohesive forces can no longer withstand the increasing extension of the liquid, the limiting — or maximum — negative pressure has been reached and the water column breaks, the eminent scientist explained.

By spinning a Z-shaped capillary tube of water at high speeds, Dr. Briggs has obtained a limiting negative pressure for water of 273 atmospheres (about 4,000 pounds per square inch), he reported. This means that the column of water in the tube did not break and fly out the open ends until the centrifugal force due to the spinning was equivalent to the pull of a column of water 9,000 feet high.

This maximum value of negative pressure was reached at 50° F., Dr. Briggs said, adding that the pressure is profoundly influenced by temperature. At freezing temperature, for instance, the limiting pressure is only 8 atmospheres, while above 50 degrees the pressure drops from the 273-atmosphere maximum to 213 atmospheres at 120°.

"Most other liquids examined have limiting negative presures comparable with that of water," Dr. Briggs commented. "Benzene is much lower, and mercury is the highest of all with 420 atmospheres."

The fact that water can withstand a large negative pressure is of tremen-

XUM

dous importance in nature, the speaker said. Without it we could have no tall trees. Water is lifted up to the tops of the giant Sequoias by the pull of minute concave capillary surfaces in the interior of the leaves. This means that the water inside the Sequoia leaf must be under a negative pressure of about 10 atmospheres (147 pounds per square inch).

But this represents only the lower limit, a situation where the root system is in a saturated soil. As the soil begins to lose water, the capillary forces developed in the capillary-like spaces in the soil oppose this loss, and the negative pressure in the leaves must correspondingly increase.

As the soil continues to lose water, the struggle between the pull of the tree and the opposing pull of the soil results in the development of negative pressures many times that arising from the height of the tree alone. Large negative stresses are also set up when soil water is pulled from a moist into a drier soil through capillary action.

M. P. E. Berthelot, the French chemist, was the first to show, in 1805, that water will withstand a large negative pressure, Dr. Briggs pointed out. This was demonstrated by heating and cooling water in a sealed glass capillary tube. Berthelot calculated the maximum negative pressure to be 50 atmospheres.

Osborne Reynolds was the first to use centrifugal force to measure negative pressure, in 1878, Dr. Briggs said. This was done by rotating a U-shaped tube in a lathe. The maximum value attained was about 5 atmospheres.

Invisible Light Explores Crystals

▶ THE INTERIOR of crystals is being explored at the University of California at Los Angeles by probing rays of invisible light.

"Although a great deal of work has been done with light behavior in crystals, there is much to learn from the erratic path of invisible light (infrared) as it bounces around among crystal molecules," say R. M. Vanderberg and Donald Weber, who are doing the research.

The manner in which a particular crystal structure permits certain portions or wavelengths of polarized infrared light to pass through while blocking out others is helping to establish the molecular arrangement of several crystals previously not well known. For example, water molecules in crystals will absorb different polarizations of infrared light in different amounts. When all water molecules in a crystal are lined up, use can be made of this fact to determine their orientation. This supplements data on crystal structure supplied by X-rays, which cannot give the positions of hydrogen atoms.

Such studies may throw some light upon how the structure of crystals such as lithium sulfate can be related to their ability to convert electrical energy into mechanical vibrations and vice versa. It is this property that makes them useful in certain electronic instruments.

New Developments in Healing Chemicals

Chemicals That Rout Diseases

➤ IN THE FUTURE, tuberculosis patients who recover under treatment with the new TB-fighting drugs may go on taking their medicines for the rest of their lives. The object would be to prevent relapses of the disease.

This new idea in the fight against the white plague is now being tried by 54 patients at Montefiore Hospital, New York City, and the hospital's Westchester Division at Bedford Hills, N.Y. They are making the trial under the direction of Drs. Alfred S. Dooneief and K. Eileen Hite.

It is never certain, the doctors point out, that all TB germs have been removed from a patient when a badly involved lung lobe or piece of lung has been cut out. There may still be foci of germs that could not be seen with X-rays or felt by the surgeon while operating. It cannot be assumed, either, that these foci of germs are completely sterilized by any arbitrary period of drug treatment. And so long as they are present, there is always the danger of their sparking a relapse.

But very long time, perhaps lifetime, treatment with the modern medicines may really rout the germs or hold them at bay enough to prevent any relapse. Drug treatment for TB has now reached the point where this idea seems worth trying, Drs. Dooneief and Hite think.

The 52 patients making the trial range in age from 14 to 64. Some have minimal, some moderately advanced and some far advanced tuberculosis. They have been getting streptomycin, PAS (para aminosalicylic acid) and isoniazid in various combinations for periods from 13 months to 32 months. This drug treatment will be continued indefinitely after the patients are discharged from the hospital and go back home and to full time activity at work or school or elsewhere.

The duration of treatment will be limited, according to present plans, only by the patient's willingness to go on taking the medicines, signs of drug toxicity and germ resistance.

So far, no patients have relapsed and all have been willing to go on taking the medicines. Resistance of the germs has not yet become a problem.

Drug side-effects have been observed more frequently as treatment is prolonged, but to date, and up to three years of treatment, they have not been serious in comparison with the risks of the infection itself.

Drug Helps Chronic Colitis

➤ ISONIAZID, already famous as a remedy for tuberculosis, may turn out to be a cure for a disease termed "one of the greatest enigmas of medicine," chronic ulcerative colitis.

Uniformly good results with this treatment in five colitis patients are announced by Dr. David A. Susnow of Mount Zion Hospital, San Francisco, in a preliminary report to the

XUM

California Medical Association's official journal, *California Medicine*.

The patients did not have tuberculosis but had suffered from ulcerative colitis for from one to 40 years. When started on the isoniazid they were having relapses that had lasted from two to six months.

Within 11 days of isoniazid treatment the first patient felt better and had gained five pounds. Diarrhea had stopped and the rectal mucous membrane was practically normal. The patient took the drug for five months. At the end of six months he was again examined and found well, and had had no relapse of the colitis. The other cases showed similar benefit.

Dr. Susnow does not try to explain why this anti-TB drug helped the colitis patients. Since it has little or no serious toxicity, he thinks it should be tried in a larger series of patients for proper evaluation of its effects. His patients took it three times a day in doses about the same as used for treating tuberculosis.

Body Cement Dissolver

➤ Babies sick with infectious diarrhea which sometimes runs rampant in nurseries are now being helped to recover, thanks to fundamental research at the Worcester Foundation for Experimental Biology at Shrewsbury, Mass.

These babies lose a great deal of water and salt and cannot keep any food down. Like dried out plants, they may die unless vital needs are replaced. Their veins are so small, however, that they cannot be vein-fed as older patients are. Consequently doctors in the past had to inject fluids under the babies' skin. The process, called hypodermoclysis, is slow and painful because the fluid goes in slowly and makes a big swelling that hurts.

Dr. Oscar Hechter of the Worcester Foundation happened to see this tedious, painful procedure one day. Dr. Hechter had been doing research on an enzyme chemical called hyaluronidase. This enzyme, he knew, can penetrate and quickly dissolve a cellular cement which binds together tissues in the body. At the time he saw the sick babies getting hypodermocylsis he was investigating the effects of hyaluronidase on the cellular cement in the skin of animals.

He thought it might be useful for getting needed fluid into the babies' bodies more quickly and easily. With Drs. Saul K. Dopkeen and Milton H. Yudell of Tufts Medical School, Boston, and Hahnemann Hospital, Worcester, tests were made. The scientists tried the chemical on themselves first and found it worked and caused no ill effects.

Then came the trial on sick babies. These trials were successful. When a little hyaluronidase was injected before starting the fluid, twice as much fluid could be given in one-fourth the time. No hard lumps formed where the fluid was being injected. The baby got its needed fluid and was able to recover when a sulfa drug and penicillin routed the germs causing the sickness.

New Thyroid Chemical

➤ Patients with under-active thyroid glands can now be given a chemical remedy five times more powerful than thyroxine, the thyroid gland hormone previously used to treat such patients.

The new chemical is called triiodothyronine. It is apparently the form of the thyroid hormone that enters and acts on the body cells, while thyroxine is the form of the thyroid hormone while it is in the blood.

Triiodothyronine was discovered in human blood by Dr. Jack Gross of the State University of New York College of Medicine in Brooklyn.

Together with Dr. R. Pitt-Rivers at the National Institute for Medical Research, London, England, he isolated triiodothyronine from the thyroid of cattle, explored its physiological properties and synthesized it chemically, making it possible to test its effects on the body.

For his discovery, Dr. Gross received the 1954 $1,000 Chilean Iodine Educational Bureau Award at the meeting of the American Pharmaceutical Association which administers the award.

Witch Doctors' Snuff

➤ A CHEMICAL that affects nerves, heart and blood vessels has been extracted from a sleep-inducing snuff used by West Indian witch doctors at the time of Columbus.

The snuff is called cohoba. It comes from the seeds of a mimosa-like tree, Piptadenia peregrina. But the active chemical in it is bufotenine, Dr. Verner L. Stromberg of the National Heart Institute has discovered.

Bufotenine is much like a chemical obtained from the venom of tropical toads. Its effect is something like that of the naturally occurring chemical, serotonin, which constricts blood vessels and speeds the heart rate.

Its effect on heart and blood vessels is being studied at the Heart Institute while scientists at the National Institute of Mental Health probe its effects on nerves and mind.

Dr. Stromberg studied cohoba from seeds obtained by the Department of Agriculture from Las Mesas, Puerto Rico. He reported his work in the Journal of the American Chemical Society.

Modern Medicines Are Cheap

➤ MODERN MEDICINES are cheap. That is the new theme song of the nation's pharmacists who are tired of hearing their drug store customers complain:

"What! $8 for a little bottle of pills! That's highway robbery."

The medicine costing $8, or even $15 or $20, the druggists point out, is really a bargain. It may save not only the patient's life but hundreds of dollars in doctor, nurse and hospital bills, to say nothing of time lost from work.

In 1927, for example, the average hospital, doctor's and nurse's bill for a case of pneumonia in a Philadelphia hospital amounted to $358. The average hospital stay was five weeks and there was a further period of convalescence at home. The loss of earnings during all this brought the total cost of the illness up to about $1,000.

Today the average patient with lobar pneumonia gets well in less than two weeks without any period of convalescence. Most pneumonia patients last year were treated at home. Cost of the medicine if it was penicillin was about $15.12 at 1953 prices and $29.68 if one of the newer "broad spectrum" antibiotics was used.

This example is given by Dr. Theodore G. Klumpp, president of Winthrop-Stearns, Inc.

Single Diet Created For All Forms of Life

Universal Diet No. 1

➤ A SINGLE DIET designed to nourish all forms of life, from man to bacteria, viruses and plants, has been created by Dr. Thomas D. Luckey of the biochemistry department at the University of Missouri School of Medicine.

The diet is semisynthetic. Dr. Luckey calls it "Universal Diet No. 1" and says that it has some limitations and omissions which will be corrected when subsequent universal diets are made.

The diet has now been fed to monkeys, cats, pigs, dogs, rats, mice, rabbits, guinea pigs, an oppossum, chicks, goldfish, cockroaches, snails and tomato plants. All these grew at satisfactory rates. The guinea pigs and snails had offspring and four consecutive generations of mice and cockroaches were fed the diet.

Besides these representatives of different orders of living organisms, such much smaller organisms as yeasts, molds, fungi, algae and bacteria were kept going through 10 generations by sterile mixtures of the Universal Diet No. 1 in water.

The diet itself would never be cheered by any chef or epicure and Dr. Luckey does not say how the monkeys and other animals liked it, although sugar was added to "give it good acceptability." Also, the physical character of the diet was changed to suit the conditions of the experiment or the appeal to the animal being fed.

Large amounts of vitamins were put in, in order to satisfy any extraordinarly high requirement that some form of life might have. Special consideration was given to the salt requirements of chicks and guinea pigs, the fiber requirements of rabbits, the high protein requirement of chicks and the fat requirement of dogs.

The diet was made up of the following ingredients: purified casein (milk protein), corn oil, cornstarch, cellulose, sucrose (sugar), and included potassium, calcium, sodium, and iodide, magnesium, manganese, cobalt, zinc, iron, and an aluminum compound. Vitamins A, D, C, E, K and all the B vitamins were included.

The exact forms and quantities of these substances in the diet were given in a report to the journal, *Science*.

Dr. Luckey got the idea for the diet from considering the fact that while man and other animals eat quite different kinds of foods, the essential constituents of these foods are largely the same. Discoveries in recent years have further shown that some of the B vitamins essential to man were first discovered as substances needed by bacteria for their growth.

The universal diet, he believes, will be valuable in many kinds of research where keeping diet a constant known factor eliminates variables that could affect the findings of the research.

Science at Sea
On Nature of Water

Water as a Substance

▶If there is one chemical formula everybody knows, it's H_2O—for water. But it now appears water isn't quite so simple after all, and scientists are just beginning to understand what it is.

This disconcerting revelation was made as technical sessions of the American Chemical Society's New York meeting opened.

"After air, water is the most important factor in man's environment, yet we probably know less about water than any other common substance," Dr. Arthur M. Buswell, chief of the Illinois State Water Survey and research professor of chemistry in the University of Illinois, asserted in introducing an ACS symposium on "Water Substance."

"We know it isn't H_2O, that the liquid molecular weight depends on the size of the container, and a few other facts about its composition, structure and chemical activity, but our knowledge is woefully inadequate to solve many pressing problems," continued Dr. Buswell. Apparently the formula for water should be H_2O "taken X times," X being a number depending on how big a bucket you have.

A more complete understanding of water substance is needed in biology (our bodies are mostly water), in meteorology to understand the cause of rainfall, in chemistry to understand solutions, and in fact in just about every field of science, the speaker declared.

Most people have no trouble distinguishing ice from water and may be surprised to learn that chemists find little difference between them, said Professor W. H. Rodebush, also of the University of Illinois, who was the first speaker on the program.

The most important differences are density (the weight of a given volume) and viscosity (resistance to stirring), Dr. Rodebush said. Ice has a very open chemical structure. In liquid water the individual molecules are farther apart but the open spaces are filled so that we have fluidity with increased density.

The study of water as a substance was begun at the University of Illinois some twenty years ago. The immediate problem was bound water. This term, which we now know to be a misnomer, is illustrated by the frost resistance of winter wheat.

Certain varieties of wheat showed great resistance to frost although they contained as much water as the non-resistant varieties. This water was said to be "bound." The bound water does not freeze and undergo the sudden expansion that bursts the cell of the living plant. The most startling fact is that certain varieties of corn are frosted at temperatures of 40 degrees Fahrenheit—8 degrees above freezing.

The tip-off to the problem of bound water came from chemical compounds

called gas hydrates. These strange ice-like compounds form at temperatures up to 40 degrees when water exists in thin layers between substances for which the water has little attraction. It is the lack of attraction rather than attraction that produces bound water.

The gas hydrates first came to attention in connection with the difficulties in pipe lines carrying natural gas where the pipe lines froze and clogged at temperatures well above the freezing point of water.

The role of the gas hydrate in the frost-resistant plant is obvious. As the weather becomes cooler the hydrate forms gradually, without damage to the cells, and occupies the same volume as would be occupied by ice. The possibility of adapting this process to the preservation of fruits and vegetables by freezing cannot be overestimated. It is the opposite of the present process of quick freezing, which must inevitably produce some damage and alteration of flavors.

➤ She wants a *diesel* iron!"

For The Home Lab

Organic Reactions: Nitration

by Burton L. Hawk

Nitration is simply the process of attaching the nitro group (NO_2) to the carbon atom of a compound. And, we know you will be surprised to know, the substances performing this feat are called *nitrating agents*. The victims of the reaction become "nitro" compounds. Thus benzene is nitrated to form nitrobenzene, phenol to nitrophenol, toluene to nitrotoluene, etc. But, naturally, it is not quite as simple as this. According to the conditions present, many different compounds can be obtained. We have mononitro compounds, dinitro and trinitro (see under "nitrophenols" below). The nitro compounds are valuable links in the preparation of many vital organic substances. Polynitro compounds are used extensively as explosives.

The most logical substance to use for nitrating is nitric acid. However, for most reactions it cannot be used alone as it tends to act also as an oxidizing agent. It is usually mixed with sulfuric acid. The resulting liquid is commonly referred to as "mixed acids."

We are listing below four nitration reactions which we hope will prove illustrative of the general process. We will consider benzene, phenol, naphthalene and cellulose. In the home laboratory our application of the nitration reactions must be limited. Some reactions are quite complex and others are highly explosive—not recommended for a home experiment.

Nitrobenzene

Place 3 cc. of concentrated nitric acid in a small flask. Add 5 drops of benzene and heat the mixture *gently* for a few minutes. Allow to cool and pour the mixture into a little water in a beaker. A heavy oily liquid separates out of the solution. This is nitrobenzene, sometimes called *oil of mirbane*. Note its odor of almonds, resembling that of oil of bitter almonds. It is poisonous, do not inhale too strongly.

Nitrobenzene is used in the preparation of aniline. This reaction is a *reduction*, and we will discuss it at a later date when we consider the reduction process.

Nitrophenol

Phenol is readily nitrated, yielding many products. Thus, we have the *mono*-nitrophenols (such as *o*-nitrophenol, *m*-nitrophenol, and *p*-nitrophenol), *di*-nitrophenols, and *tri*-nitrophenols. We will prepare a compound from the latter group—2,4,6-trinitrophenol, better known as *picric acid*. In this case the phenol must first be sulfonated and the resulting *p*-phenosulfonic acid nitrated.

Heat on a *water bath* a mixture of 2 grams phenol with 2.5 cc. of concentrated sulfuric acid in a small flask for 20 minutes. Cool *thoroughly*, then add 7 cc. of concentrated nitric acid. A vigorous action results and large volumes of brown fumes will pour out of the flask. When the mixture calms down,

heat again in a *water bath* for 30 minutes. Then add 20 cc. of water and immerse the flask in ice water. Picric acid separates out as a brilliant yellow precipitate. *(Caution: Picric acid explodes when rapidly heated or by percussion. Dispose of it immediately after experimenting by washing down the drain with water.)*

Nitronaphthalene

Although other compounds are known, we will only consider *l-nitronaphthalene* here. Place about ½ gram of naphthalene in a dry test tube and add a solution of mixed acids (2 cc. of concentrated sulfuric acid and 1 cc. of concentrated nitric acid), keeping the mixture at a temperature of 50 degrees. The yellow l-nitronaphthalene forms as a layer on top of the solution.

Nitrocellulose

The nitration of cellulose yields several very interesting compounds known as cellulose nitrates or, collectively, as "nitrocellulose." Using filter paper as our source of cellulose, let us prepare a sample. Cautiously mix together 4 cc. of concentrated sulfuric acid with 5 cc. of concentrated nitric acid in a beaker. Cool the solution and add several strips of good quality filter paper. Allow the paper to soak in the solution for ten minutes. Then wash thoroughly with warm water and allow to dry. The product is similar to guncotton. Ignite one end of a strip. It burns rapidly with a brilliant flash.

Guncotton is used in making smokeless powder since, when it explodes, it yields only hydrogen, nitrogen, steam, carbon dioxide and carbon monoxide, and produces no smoke.

Other cellulose nitrates, containing less nitrogen, form the compound known as *pyroxylin*. This compound is used to make celluloid.

Thus we have given a few examples of typical nitration reactions. Other compounds can be treated in similar ways to produce nitro-products. Remember that many nitro compounds are unstable and there is always the danger of explosion. Use care when experimenting with nitration reactions.

Many of our powerful explosives are produced by the process of nitration. (That is, they *were* considered powerful explosives before the advent of the atom bomb.) When a mixture of nitric and sulfuric acids is mixed with glycerin, *nitroglycerin* is obtained. Actually this compound is an ester and should be properly called glyceryl nitrate. It explodes when heated to 180 degrees or when struck.

The nitration of toluene produces several nitrotoluenes, among them *trinitrotoluene*, or T.N.T. It only explodes when detonated or burned in large quantities, thus it may be handled fairly safely.

The hippopotamus differs from the rhinoceros in having four instead of three toes.

Enough milk is produced annually in America to fill a river 3,000 miles long, 40 feet wide and 3 feet deep.

A paradox is the fact that the decline in child and infant mortality has created an increased demand for medical care.

Come War, You'll Learn To Know These Chemicals

Phosphorus Nerve Gases

IF WAR COMES, the average person who has learned such unfamiliar terms as neutron and nuclear fission, thanks to the A and H bombs, may be just as much interested in knowing the following:

Isopropyl methyl phosphonofluoridate.

Dimethylamido ethoxyl phosphoryl cyanide.

These are the chemical names for two nerve gases. The isopropyl job has the short name, sarin. The other has been shortnamed or nicknamed tabun.

They were once considered for war use by German military authorities. Almost everything about them except the fact of their existence was a closely guarded secret of our military officials during World War II and for some time after.

Now Drs. Stephen Krop and A. M. Kunkel, civilian scientists with the Army Chemical Corps, report on work done on these nerve gases in 1947 and 1948. The full names and structural formulas are given in their account, to show how they are related to another well known anticholinesterase chemical, DFP.

DFP, short for di-isopropyl fluorophosphate, has been used medically for some years to treat the eye disease, glaucoma, and the muscle weakness disease, myasthenia gravis.

Like the two nerve gases, DFP stops the action of an important body chemical that is essential to the nerves performing their function. Hence the name, nerve gases. The body chemical is the enzyme, cholinesterase, so nerve gases and DFP are called anticholinesterases.

DFP and sarin are alike in that each has a phosphorus and a fluorine atom. Tabun has the phosphorus but instead of the fluorine it has a cyanide group in its molecule. DFP has more oxygen and more hydrogen than either sarin or tabun. And tabun has an extra nitrogen atom besides the one in the cyanide.

The effects of these nerve gases have often been given, although their chemistry, even after secrecy was lifted, has been told chiefly to chemists, pharmacologists and other scientists. Drs. Krop and Kunkel sum them up by saying they "exert profound effects on the respiration, circulation, central nervous system and gastrointestinal tract."

In lay language they have been described as follows:

If a high concentration is breathed for a few seconds, death occurs. Exposure even to traces of their vapors causes marked constriction of the pupils of the eyes. The bronchial tubes become constricted, there is sudden difficulty in breathing, accompanied by coughing, shortness of breath and watery discharge from the nose.

A slightly greater exposure causes painful constriction of the focusing

muscles of the eyes. There is pain when the person afflicted tries to focus his eyes and often bright light is painful.

Severe exposure causes irrational behavior, hence the reference to nerve gases as "madness gases." There is also emotional instability, depression, restlessness and tremor in such cases. Milder cases of nerve gas poisoning may show such mental symptoms as giddiness, tension, anxiety, insomnia and excessive dreaming.

The report of the 1947-1948 work on them by Drs. Krop and Kunkel is now reaching scientists through the Proceedings of the Society for Experimental Biology and Medicine.

Link 1,800 Counters of Cosmic Rays

➤ GEIGER counters spread over half a square mile will be tied together by a giant electronic "brain" to measure cosmic rays bombarding earth from outer space.

The 1,800 nuclear measuring devices will be recording arrival of particles with energies entirely beyond the realm of man-made multi-billion volt machines. The computing device linking the 1,800 instruments will have been instructed how to handle this mass of data.

Australia will be the scene of this gigantic counting scheme, sponsored by the University of Sydney. The computer used will be the "Silliac," a duplicate of the University of Illinois machine, "Illiac." The two institutions will carry on a joint program on the use and improvement of electronic computers.

Device Detects Ozone Traces in Air

➤ AN EXTREMELY sensitive device to detect traces of ozone in air is being used by scientists to improve rubber products for home and industry.

The machine, called an ozonometer, can spot less than a tablespoon of ozone in the air in a 12-by-15-foot room, or a concentration of one part of ozone to 100,000,000 parts of air.

Ozone is an extraordinarily active form of oxygen, with a peculiarly pungent odor often noticed during thunderstorms. It is sometimes erroneously used as a synonym of fresh air.

Scientists at B. F. Goodrich's research center in Brecksville, Ohio, invented the ozonometer because ozone is the deadliest enemy of rubber. It causes cracking and deterioration when rubber products are stored. Serious damage occurs in urban areas where smog causes the formation of ozone in air, the scientists said.

The machine uses a stretched rubber thread as the basis of measurement. The thread's tension is directly affected by the amount of ozone in the air. The ozonometer makes it possible to measure the exact effectiveness of experimental anti-ozone chemicals in rubber, an aid in the development of new compounds that will not be affected by ozone.

Army Studies Antidotes To Phosphorus Poisons

First Aid For Nerve Gas

▸NEW TECHNIQUES in first aid for accidental exposure to phosphorus insecticides have been developed through recent Army Chemical Corps research.

Phosphorus insecticides are now being widely used and a careful study of occasional accidental poisonings arising from careless handling has resulted in a "considerably" improved outlook for recovery from the effects of such overexposure, according to Dr. Gustave Freeman, a research physician in the Chemical Corps Medical Laboratories at the Army Chemical Center, Edgewood, Md.

Improvements in first aid equipment and a better understanding of dosage sizes and methods have made present procedures more effective, declared Dr. Freeman, who is chief of the Medical Laboratories' clinical investigation branch. First aid consists primarily of administration of artificial respiration and large doses of the well known drug atropine, he said.

Such insecticides as parathion and TEPP, if taken in large overdoses, attack the nerve centers which control breathing and may result in suffocation if proper preventive measures are not taken.

Nerve gases, recent additions to the arsenal of war, would act upon their victims like super-potent phosphorus insecticides and, for this reason, the two types of poisoning have been studied together by the Chemical Corps. Much has been learned about their effects, stated Dr. Freeman, and the methods which have proved effective with the insecticides would also be used for exposure to nerve gas.

Survival is dependent upon supplying oxygen before irreversible damage is done to such vital tissue as the brain, he explained. The victim can either maintain or recover his capacity to breathe by having the effect of the agent blocked with atropine, or artificial respiration needs to be supplied until breathing returns spontaneously with or without the aid of atropine. In any event, time is most important.

Atropine is available at the Chemical Center in properly large dose units with attached sterile needles for immediate injection. Doses that suffice for usual medical requirements are entirely inadequate. In severe poisoning, an initial dose of six milligrams (about 10 times the usually prescribed amount) is in order. This greatly encourages spontaneous breathing and keeps the air passages relatively free of secretion.

Manual artificial respiration by the back-pressure, arm-lift method of Holger-Nielsen is recommended and may serve the purpose of resuscitation in adequately atropinized individuals but may fail in the presence of increased hindrance to air flow. Ideal circumstances are afforded by a combination of mechanical suction for aspiration, insertion of a tube through the larynx and the administration of oxygen or air by means of a mechanical respirator. Patients have survived respiratory failure with artificial respiration alone

or in conjunction with obviously inadequate atropine. The great advantage of atropine at all stages cannot be underestimated but reoxygenation is essential when breathing is inadequate.

Procedures for medical care of nerve gas and phosphorus insecticide victims were developed through extensive studies at the Army Chemical Center, undertaken in order to provide optimum defense against the military use of nerve gas. Researchers have also obtained data useful to investigative medicine for the treatment of naturally occurring diseases.

The studies were made with dogs and with persons accidentally exposed to insecticides and (in one case) to nerve gas. There have been fewer and fewer accidents among workers handling phosphorus insecticides, in spite of the rapidly growing usage of such materials, he said.

"We have taken advantage of the occasional cases of severe poisoning with the cooperation of physicians, agricultural workers, chemical firms and government agencies to study the effects of treatment in man. Altogether, this rich experience has been the basis for considerable improvement in the outlook for survival following poisoning with nerve gas, and, we are confident, with insecticides as well.

"An incident of extraordinary value was an exposure to a fatal concentration of volatilized nerve gas. Both the surprise and the extremely rapid rate of poisoning by inhalation gave the impression that the victim became totally paralyzed within five minutes after having walked into the polluted area. He staggered away and, after making a few convulsive movements, fell limply to the floor and ceased to breathe. Immediate availability of first aid and expert medical treatment, subsequently, were responsible for complete recovery."

Poisoning can occur from contact with the skin or absorption through the eyes, as well as by inhalation. The relatively slow absorption from the skin leads to insidious changes so that the uninitiated may remain disarmed too long owing to mildness of symptoms, according to Dr. Freeman, whereas one who understands the symptoms may heed their warning in time.

Radioactivity Affects Film Makers

➤ RADIOACTIVE dust particles drifting across the Pacific into the United States could cause photographic film makers to shut down their plants for a day or so.

Although the particles are not "strong" enough to harm human beings, they can fog film as easily as light can. This is particularly true if the bits of radioactive dust come in direct contact with the film.

Dr. Walter C. McCrone, senior chemist at Armour Research Foundation of Illinois Institute of Technology, said films probably would not be fogged by the radioactive dust if kept in the original wrapper before and after using.

At most it could have only the nuisance effect of forcing manufacturers of photographic film to close down their plants on the days when radioactive dustfall following bomb explosions is especially heavy.

Lungs Irritated by Metal Ammonium Salts

Clue to Smog Deaths

▸THE INVISIBLE killers in great, death-dealing smogs appear to be tiny particles of acidic salts that dissolve in the fluids of the respiratory tract and cause acute irritation of the surrounding tissues.

New research techniques—applied to air samples from the Donora, Pa., smog of 1948 and the great London smog of 1952 in which more than 1,000 persons died—indicate that the guilty substances, known technically as metallic ammonium sulfates, come from coal smoke, asserted W. C. L. Hemeon, engineering director of the Industrial Hygiene Foundation of America, Inc., of The Mellon Institute, Pittsburgh, Pa., at the meeting of the American Chemical Society.

Fatalities and illnesses in acute smog episodes probably are the result of simple irritation of the respiratory tract by these substances and are not due to systemic poisoning by sulfur dioxide or other atmospheric gases, Mr. Hemeon said. He identified the irritant particles as acidic salts—usually the sulfates and the chlorides of ammonia in combination with zinc or other metals.

Previous studies of the major smogs have failed to pin-point lethal agents, and speculation has ranged from vague use of the term "air pollution" to sulfur dioxide gas.

The new research just described was unique in two respects. First, an effort was made to analyze only tiny particles, less than five microns (one 5-thousandth of an inch) in diameter, since there is biological evidence that larger particles do not penertate deeply into the respiratory tract. This was done by using special filter-paper collectors.

And secondly, acting on the hunch that any substance producing major irritation of the respiratory tract must do so by solution in fluids of the respiratory system, the chemical engineer concentrated his analyses on the water-soluble fractions of smog-sample particles and discarded insoluble material.

About 22 per cent of the particles in a sample of polluted air preserved from the Donora smog proved to be water-soluble, Mr. Hemeon said.

Calculations based on quantitative and spectrographic analysis and x-ray diffractions of this water-soluble material showed that it probably contained about 58 per cent zinc ammonium sulfate or other metallic ammonium sulfates. Similar analysis of typical air samples taken recently from two towns near Pittsburgh showed only 9 to 13 per cent of this salt.

The Donora sample also contained 21 per cent zinc sulfate, against none in the comparison specimens.

Water-soluble particles from the London smog proved to be composed chiefly of ammonium chloride and calcium sulfate in combination with traces of sodium, potassium, aluminum, magnesium, zinc, and other metals, Mr. Hemeon said, adding:

"Such salts (the sulfates and chlorides of ammonia) may be the primary substances responsible for respiratory irritation in smog episodes . . . it is readily demonstrable that ammonium chloride and ammonium sulfate are irritating on inhalation."

The sulfur in the sulfates obviously originates from the combustion of coal. It may unite directly with metallic compounds to form soluble sulfur salts which become sulfates. This hypothesis would relieve one of the necessity for adherence to the idea that has wide credence, that sulfur dioxide gas is directly capable of irritation of the respiratory tracts, even in low concentrations around two parts per million, which is the highest concentration appearing during smog episodes.

"It appears to us that sulfur dioxide gas is significant only as it becomes transformed to ammonium and metallic salts," Mr. Hemeon said.

The preponderance of evidence indicates that the irritant is particulate matter, whether liquid or solid, rather than gaseous, the chemical engineer said, and further study of the water-soluble fraction of smog particles can be expected to yield more clear-cut information. He concluded:

"There are not in existence any scientific data to illuminate the question of chronic health hazards from air pollution. There is, however, no question concerning the effects of acute air pollution exposures."

Safer, Better Insect Killers

➤ How to poison pests without killing plants they feed on or men who make the poisons claimed the attention of chemists at a recent meeting of the American Chemical Society.

Insects may die because the farmer sprays the insecticide directly on them, because they eat the poison clinging to the surface of the leaf they chew, or because the plant they feed on has taken into its juices substances harmless to the plant but deadly to the bug.

Methods for measuring residues of such chemicals in plants were reported by industrial and government specialists. The toxicity of organic phosphorus compounds is greatest in phosphates and phosphonates, say Jiro K. Kodama, Hamilton H. Anderson and Charles Henri Hine of the University of California School of Medicine, San Francisco. The effects are cholinesterase inhibition, degeneration of the nervous system and irritation of the surface tissues.

Deaths have resulted from swallowing these chemicals but not from handling them, say the California scientists.

The effect of soils, water, oxygen, sunlight and solvents and emulsifiers carrying the dusts and natural enzymes on pesticides and on the corrosion of metal equipment used with them is being studied. Improved insecticides should result.

Plants Help Chemists Determine Air Pollution

Leaf Damage Records Smog

▶ SPINACH has been drafted for Los Angeles' war on smog, the American Chemical Society learned from Wilfred M. Noble, air pollution plant specialist of Los Angeles County's Air Pollution Control District.

Spinach, petunias and annual blue grass are now being put to work by the Air Pollution Control District in test stations throughout the Los Angeles area to determine the causes, occurrence and intensity of smog, said Mr. Noble, a chemist who has been with the district for six years. A number of plants have been observed to display a distinctive damage pattern when exposed to smog, and a study of this damage yields much information helpful to the smog control program.

These studies have also shown that gasoline and automobile exhaust fumes are potential factors in the production of smog, he added. Smog damage has been estimated to cause $480,000 annual loss in vegetable crops alone in Los Angeles County.

Animal tissue cells are similar to plant cells in many ways. Because of this, Mr. Noble stated, the district will widen the scope of present experiments with vegetation. The researchers plan to isolate single plant cells and study the effects of various pollutants in order to determine why certain cells are more sensitive than others.

Damage to plants, induced by artificial smog in the laboratory, might serve as a botanical tool to study the growth and development of leaves, he suggested.

Only plant cells in a specific stage of maturity suffer this damage, which had not been described previously, observed Mr. Noble.

In 1952 it became apparent that the location of damage was related to the progressive development of the leaf. On many plants, damage from a single exposure was frequently found on only three leaves of any one stalk. The immature and old leaves showed no injury. Of the three which were damaged, the youngest would be injured at the tip, the next older about a third of the way down from the tip, and the next near the base. This location corresponds to the known progression of maturation of leaves. The tip of most leaves matures first and the age of the cells decreases progressively from the top to the base. It is known that in grass-like plants growth continues in the base of the leaf for a long time. This results in a series of bands, one for each successive day of exposure.

"During a period when smog in the San Fernando Valley occurred repeatedly for several consecutive days, six successive diagonally transverse purple-brown bands of injury were found on single blades of rye grass," Mr. Noble explained. "The intermediate areas remained undamaged since smog injury does not occur at night. This is not because plants are insensitive at night. Fumigations with synthetic smog have

produced damage at night, in darkness. It is probably due to the fact that all of the effects of smog in the atmosphere disappear shortly after sunset. This indicates that smog requires light for its formation, or possibly that light promotes the damaging reaction."

Three factors have been observed to affect the size of the area damaged. Rapid growth causes an increase in the width of the band of some plants. A high concentration of pollutants causes injury to the more resistant cells so that larger areas will be affected. Extended periods of exposure, repeated daily, may cause an overlapping of bands in some plants which normally have wide bands of damage.

In addition to these factors, broad-leaved plants, such as spinach, show the largest area of sensitivity at about one-third of the distance from the apex to the base of the leaf.

Mr. Noble also reported that plants exposed to smog are reduced in size. Endive grown in filtered air was found to be twice the size of that grown in typical smog-polluted air.

The pattern of damage caused by smog can be recognized because it differs from that done by insects or frost, and no such precise pattern has been produced by any other gas. Mr. Noble and his co-workers have tested a number of air-contaminating gases on laboratory plants, and found the pattern to be distinctive for smog.

New Device Makes Fresh Water From Sea

➤ A NEW DEVICE makes fresh water out of sea water. It is an osmotic membrane, using the principle by which body organs and individual cells purify liquids. It was built by Gerald Hassler, University of California at Los Angeles engineer.

Osmotic membranes have been proposed before in connection with sea water distillation. However, previous membranes have been like sieves with tiny holes which allow small molecules to pass through while rejecting larger ones.

Hassler's membrane is an extremely thin oil layer supported by capillary action. It has no holes as such but water molecules can diffuse through it while other molecules are blocked.

Mr. Hassler believes he can ultimately produce a cubic yard package of oil membranes capable of producing 2,000 gallons of fresh water per day. The unit would cost about $1,000 and last perhaps 20 years.

Preliminary experiments have been supported by funds from the State of California. Present research is being supported by a $10,000 grant from the Department of Interior's Saline Water Project.

Animal fats and vegetable oils were the common lubricants until the advent of petroleum oil in 1860.

Blastomycosis is a term applied to a group of closely related diseases caused by yeast-like organisms.

New Ice Cream Substitutes Bring Benefits — And Trouble

Frozen Desserts Confuse Law

▸ Two LOW-COST ice cream substitutes are pleasing millions of consumers in the states in which their sale is permitted. But the products are so similar to ice cream that manufacturers and consumers alike are often confused and troubled.

Mellorine is difficult to distinguish from ice cream, even in the laboratory. In this product, vegetable or animal oils have been substituted for the butterfat in ice cream with a resulting loss in vitamin A content.

The name "Mellorine" was originated by the Texas State Department of Health, developers of the product, which is willing to have other states use the term for the same type of product. "Mellorine" may soon be as common a word as "sherbet" or "ice cream."

Unlike Mellorine, ice milk has the blessing of the dairy industry. Ice milk is as much a dairy product as ice cream, but has more milk solids and fewer calories than either ice cream or Mellorine. It is not as smooth as true ice cream because it has only about one-third the butterfat.

The frozen dessert industry's new and old products confuse even the federal government. Hearings toward developing standards and definitions for ice cream and "related products" ended Dec. 31, 1952, after nearly two years, 22,555 pages of testimony and 443 exhibits.

No federal standards for any of the frozen desserts, including ices, sherbets and frozen custards, have yet been established.

Thus, manufacturers are not quite sure how they stand in the eyes of federal law.

If Mellorine is considered an imitation ice cream and not a distinct product in its own right (there is some confusion on this point), then to be carried across state lines Mellorine must be labeled "imitation ice cream." But all the states that permit Mellorine within their borders ban the use of the words "ice cream" on any part of the package.

Consumers, of course, like the low cost of Mellorine and ice milk. By the pint Mellorine costs from three to five cents less than ice cream and ice milk costs from two to three cents less.

Mellorine-type products, although legally sold in only nine states, accounted for 1.5% of the sales of frozen desserts in 1953. Ice milk made up 8% of the total volume of desserts sold. The District of Columbia and 41 states permit the sale of ice milk.

One of the biggest reasons for the high sales of ice milk is a thick drink called "Malt-A-Plenty," "Drink-A-Plenty" and a variety of other trade names. The drink, which is very much like a milkshake, is made with ice milk instead of ice cream.

Although the drink is served in a heavy paper cup on which is printed a trade name and which omits any reference to ice cream, many people

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believe they are getting a dressed up shake.

If the price of this drink is equal to that of a milkshake of the same volume with the same amount of frozen dessert in it, the consumer is plainly not getting his money's worth.

Persons who are counting calories either for gaining or losing purposes will want to be sure of getting the dessert they ask for.

Many manufacturers are worried about their less reputable brother producers who may attempt to sell the new products as the older, established product, perhaps even charging the higher price.

The International Association of Ice Cream Manufacturers has therefore resolved that to minimize the opportunities for fraud, the sale of Mellorine should be limited "to containers of one-half gallon and less, thereby prohibiting bulk sales."

The IAICM would likewise limit the sale of colored and flavored ice milk to packages of one-half gallon or less. Fountains might still use the unflavored product, with syrups added at the fountain, for various drinks.

Restaurants would be required to serve the new products in properly marked, individual containers.

But even more damaging than fraudulent sale at the retail level to what the industry calls "the integrity of ice cream," would be the blending of butterfat with vegetable or animal oils and palming off such a product as ice cream.

The industry advocates laws prohibiting such blending, and suspension of the license to manufacture frozen desserts for those who break that law.

Mellorine is sold in Alabama, Arkansas, California, Illinois, Missouri, Montana, Oklahoma, Oregon and Texas, the state in which it developed.

Ice milk is sold in 41 states and the District of Columbia, though not always under the name "ice milk." States which bar the sale of ice milk include Delaware, Indiana, Maryland, New Hampshire, New Jersey, New York, and Pennsylvania.

Detects Flaws in Germs

➤ RADIOACTIVE phosphorus is helping detect fatal flaws and consequent vulnerable spots in disease germs of the parrot fever and virus pneumonia group, Dr. James W. Moulder of the University of Chicago told the Society of American Bacteriologists.

The germs have a diameter of about a fifty-thousandth of an inch. They are between viruses and bacteria. They are like bacteria in their response to antibiotic drugs. They are like viruses in lacking some enzymes essential for their life chemistry. Unlike viruses, however, they do have some enzymes of their own.

Once inside the cell of an animal or man, they progress in four major stages. The initial small body doubles in size, then splits several times to form a cluster. The clusters clump in a sac inside the cell. Then, 48 hours after the start of the process, the sac splits, breaks up the cell it infects, and releases a host of new germs to infect other cells.

Chemical Basis For Food Preferences Seen

Ten Kinds of Tastes

THE SAME food actually tastes different to different people and now it's possible systematically to find out what tastes like which to whom, the American Chemical Society was told at its national meeting.

Preliminary studies indicate that there are at least ten distinctly different classes of taste reactors among the general public, that they can be identified by a simple chemical test, and that each class has distinct food preferences, probably because the same food causes a different taste sensation in each class. The Society's Division of Agricultural and Food Chemistry heard this at a special symposium on "The Chemical Aspects of Flavor and Odor Perception."

This chemical difference among people — and not environmental conditions, psychological reasons, acquired tastes or heredity — probably is the reason why junior can't stand spinach and sauerkraut while his brother gobbles them up, according to Dr. Arthur L. Fox, research director of the Colgate-Palmolive Company, Jersey City, N. J.

If the evidence is substantiated by further work, he said, there may come a day when Army recruits are grouped according to their chemical taste-test reactions, so that benevolent mess sergeants can plan more pleasing menus for them.

The trouble with most references to taste, Dr. Fox reported, is that they include not only true taste but also aroma, or flavor. In addition, most foods usually stimulate more than one true taste at the same time.

To avert this difficulty, he used two chemicals that are odorless but produce pure, true taste sensations. One was phenyl thiocarbamide, which tastes exceedingly bitter to some people and causes no taste sensation at all in others. The second is sodium benzoate, which different individuals describe as sweet, sour, bitter, salty or tasteless.

By testing first with phenyl thiocarbamide, Dr. Fox said, he divided random subjects into two groups, "bitter" and "tasteless." Then, using sodium benzoate, he was able to divide each of these groups into five subgroups—"bitter-salty," "tasteless-salty," "bitter-sweet," "tasteless-sweet," and so on.

All the subjects—without reference to their taste-test groupings—then were asked to express their like or dislike for nine foods, ranging from sauerkraut to butermilk to turnips to strong cheese, in order to establish a normal baseline.

If pure taste is a determining factor in food preferences, Dr. Fox explained, then differences should be found in the food likes and dislikes among the classes as determined by the chemicals alone.

When the subjects' food likes and dislikes were examined according to their grouping on the chemical taste-test, this proved to be the case. Each

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group varied sharply from the overall normal on at least some foods. For example, the sauerkraut preferences of the entire group of subjects showed that about 20 per cent liked it and 56 per cent didn't, with the rest indifferent. But in the "bitter-salty" group, only 17.3 per cent liked it and 82.4 per cent didn't.

The 10 taste-test groups include four big ones that seem to cover 76 per cent of all people, Dr. Fox noted. While panels of expert food taste-testers should include a representative of each of the 10 groups, he suggested, special weight should be given to the opinions of experts from the four major groups —and companies bringing out a new food or beverage should make certain it is acceptable to these four groups.

Another taste researcher, Dr. Hubert Frings, professor of zoology at The Pennsylvania State University, told the symposium the classic division of taste into four primary qualities—salt, sweet, sour and bitter—is a misleading oversimplification.

By studying taste responses in roaches, caterpillars, rabbits, quail—and men—he found that differences in taste really reflect differences in the power of various substances to stimulate taste-receptors.

The studies indicated that different substances—when lined up according to their receptor stimulating ability—form a whole spectral series, like colors, with none more primary than others.

A bold, adventurous new theory of taste may—if it proves correct—make the human tongue the chemists' greatest instrument for prying out secrets of molecular structure so delicate that they cannot be determined by today's complex mechanical instruments, according to Dr. Robert B. Warfield of the Bristol-Myers Company, Hillside, N. J.

Dr. Warfield told the symposium he believes taste is a chemical sense responding directly to the interaction of molecules of the tasted substance with sensory receptors in the mouth. Hence, taste might have the capacity to reveal structural details of chemical compounds which are not readily ascertained from visual data mediated by physical instruments.

The scientist said he found other researchers had discovered that ordinary potassium chloride and other salts taste sweet in very low concentrations, bitter in medium concentrations, and salty in strong concentrations.

This might be due, he reasoned, to the fact that the positive and negative ions in the salt are forced closer together at higher concentrations. If the tongue has taste receptors each composed of a positive and negative component, the "sweet" receptors might be those in which the positive and negative components are widely spaced, the "bitter" might be those of intermediate spacing, and the "salty" might be those in which the components are close together.

The three kinds of receptors thus would resemble three electrical wall sockets with their slots spaced differently—and molecules of sweet, bitter or salty substances would be like three different-sized plugs. Each time a plug fit a socket—or a molecule fit a receptor—a nerve impulse would register the appropriate taste sensation.

New Chemicals to Control Flies All Summer Long

Extenders For Insecticides

▸By NEXT SUMMER you may be able to spray your patio, picnic grounds or campsite once and be rid of flies, mosquitoes and other insects for the entire season.

Chemical "extenders" added to our present insecticides, such as DDT, aldrin and lindane, will do the job, U.S. Department of Agriculture scientists hope.

When one of these extenders, methyl ethyl ketone, was used as a solvent for DDT, spray residues on foliage killed flies for 60 days and longer, compared to less than 15 days when the DDT was in an oil solution.

The fly-killing ability of aldrin and lindane was stepped up from less than 10 days under outdoor conditions to give "nearly perfect fly control" for more than 102 days. That would take care of June, July, August and the first week of September.

The scientists who developed the insecticide extender idea are W. N. Sullivan, entomologist, and Irvine Hornstein, chemist, working under the direction of R. C. Roark of the Agricultural Research Center at Beltsville, Md.

The new sprays while being tested were put on pine and spruce trees. At intervals twigs from the sprayed trees were taken into the laboratory and tested against flies. During the test period, begun in the fall, daily temperatures varied from as high as 80 degrees Fahrenheit to as low as 23 degrees. More than eight and a half inches of rain and snow fell during the period, showing that the new sprays will not wash off in summer rains.

Department officials explain how the extenders work. Applied as an oil-base spray, DDT does not form long-lasting residues on foliage because the oil carying the DDT penetrates into the leaf. However, when a highly volatile solvent such as methyl ethyl ketone is substituted for the oil in DDT sprays, it quickly vaporizes when sprayed so that only a residue of DDT remains on the foliage surface.

With aldrin and lindane sprays, using methyl ethyl ketone in place of oil only partially solves the problem of making these foliage sprays long-lived. Unlike DDT, these two insecticides are relatively volatile materials themselves. The scientists slowed down their rate of evaporation by adding a chlorinated terphenyl trade-named Arochlor to the spray solution. These insecticides are soluble in the nonvolatile chlorinated terphenyls and as a result the vapor pressure of the insecticide is lowered.

When methyl ethyl ketone insecticide sprays were applied with either a power sprayer or mist blower, very concentrated solutions containing approximately 50% by weight of the insecticide extender were used. The methyl ethyl ketone began to evaporate almost as soon as the spray left the nozzle. As the material evaporated the spray droplets became small insecticidal pellets averaging between 50 and 100 microns (about $\frac{1}{500}$ to $\frac{1}{250}$ of an

inch) in diameter, which carried for relatively long distances. The pellets adhered strongly to such target surfaces as foliage, forming a uniform deposit over the leaf or branch, but not penetrating or otherwise damaging it.

Flies were used as convenient "guinea pigs" for the tests. But it is hoped that the effect would be the same on other insect pests.

Flies Make DDT Antidote

➤ THE SECRET of how flies have become resistant to DDT and other modern insecticides has been discovered by Dr. Clyde W. Kearns and co-workers at the University of Illinois.

The flies make their own antidote to DDT and presumably to other insecticides. They do it by developing enzyme chemicals. One called DDT-dehydrochlorinase changes DDT to the nontoxic compound, DDE.

This enzyme antidote is specific for DDT. Flies apparently produce another enzyme antidote for other insecticides such as chlordane.

From a million or more flies, Dr. Kearns and associates were able to get enough of the anti-DDT stuff to study it. They hope to purify it, find out the precise mechanism of the DDT detoxifying process, and then, presumably, find a way to circumvent the antidotal enzyme.

These findings apparently are not expected very soon. A $75,000 Rockefeller Foundation grant to aid the research is to run for a five-year period.

Dieldrin OK For Homes

➤ A POWERFUL, long-lasting insecticide used this summer to battle infestations of armyworms in north-central states will be available soon for use in controlling household insects as a result of recent label acceptance by the U.S. Department of Agriculture.

The chemical, dieldrin (pronounced DEEL-drin), kills roaches, ants, silverfish, ticks, and even wasps and mud daubers, its manufacturer, the Shell Chemical Corporation, claims.

In tests at Cornell University, dieldrin killed houseflies in five seconds after contact with them.

The insecticide should be used for spot application to floors, sills or wherever insects may crawl or alight.

Dieldrin should not be sprayed into the air because repeated or prolonged breathing of the odorless chemical may prove injurious. It has been banned from use in aerosol bombs.

Users of dieldrin should be careful not to get it on their skins. If accidentally spilled on skin areas it should be washed off immediately.

The U. S. Department of Agriculture's acceptance does not mean, necessarily, that it recommends the product. It does mean that when the chemical is used as directed on the label, the results claimed on the label will follow.

Dieldrin will be distributed by several companies as a dust or spray in various formulations under their own trade names.

Telephone cables are now protected by layers of aluminum, terne coated steel, a cement coating and a polyethylene jacket, instead of paper and lead used for more than 50 years.

Ultra high frequency radio messages can be transmitted to more distant points by reflection from the moon.

Finely Powdered Metals Now Processed at High Temperatures

Sintered Solids

Reprinted from the Industrial Bulletin of Arthur D. Little, Inc.

▶SINTERED solids, made by powder metallurgy techniques, have grown vigorously in commercial importance in the last decade. Such materials include ceramics and ceramic-metal mixtures as well as special metals and alloys designed for high strength and resistance to heat and corrosion.

To form sintered solids, powders are pressed into a die cavity, and the ejected "green piece" is then fired or "sintered," under high pressure and/or very high temperature. Such standard metallurgical procedures have now been extended by the introduction of precision dies to permit manufacture of sintered solid parts to close tolerances. Ceramics produced by this technique, for example, utilize fine powders processed at high pressure and under carefully controlled firing conditions. For their specialized applications they are considerably superior to items produced by conventional slip-casting methods.

Barium titanate, made from titanium dioxide and barium carbonate, is an example of a nonmetallic sintered solid. The material can store unusually large electrical charges, and thus finds wide use in the manufacture of condensers for radio and television sets. About eight million pounds of barium titanate is sold annually to form sintered solids, and about 80 to 90 per cent of this goes into such condensers. There are 10 to 12 barium titanate condensers in each radio manufactured and 50 to 60 in each TV set. In addition, barium titanate, when suitably prepared, is strongly piezo-electric—i.e., it produces a surface charge of electricity when subjected to mechanical stress, or vice versa. Consequently, it is used as a generator of very-high-frequency sound, where it is a satisfactory and considerably cheaper substitute for quartz crystals.

Because barium titanate ceramics can hold a substantial electric charge in a small space, they are ideal for miniature circuits, such as in hearing aids and phonograph pickups. The ceramics do not absorb water and thus are suitable for underwater sound gear. To obtain satisfactory performance the initial powders must be carefully formulated to contain minute impurities that add to the electrical properties of the end product. In addition, sintering must be carefully controlled; even so, uniform performance is difficult to achieve.

Another type of sintered solids is the ferrites, generally made from mixtures of manganese oxide, zinc oxide, etc., with iron oxide. Ferrites carry a magnetic flux, as does iron, but they work much better than ferromagnetic materials at high radio frequencies; consequently, they have come into their own in the field of electronics. TV components that control the horizontal deflection of the electron beam

across the screen are all made of ferrites. Additional uses include the conversion of electrical into mechanical energy as in phonograph recording heads, antennas for portable radios, and miniature transformers. Such uses, both military and civilian, have caused production to grow from almost nothing to an estimated six million pounds of ferrite parts in 1953.

Other sintered solids remain in the development stage, or in the early stages of commercial application. The cermets, for example, show promise for aircraft applications, but the problem of low impact resistance must still be overcome. Borides and nitrides of various metals are beginning to find application as specialty materials where high strength and resistance to high temperatures and corrosion are important. The non-metallic and partly-metallic sintered solids supplement more and more the conventional metal and alloy powders.

Iron by Pounds From Waste

➤ WHAT AMOUNTS TO a new mining method for obtaining iron was described recently to chemists interested in improving water resources.

The iron is found in waste water from industrial plants which use acid to clean the surface of steel products.

The method is ion exchange, once a laboratory procedure but now increasingly used in industrial installations.

The yield of iron from this process which proceeds atom by atom is measured by the pound.

A variety of plastic resins is available which will draw this iron out of the waste water solution trickling through the ion exchange apparatus. A particular kind of resin, known as a quaternary type anion exchanger, was reported to the meeting of American Chemical Society experts by A. C. Reents and F. H. Kahler of the Illinois Water Treatment Co., Rockford, Ill.

This resin can be made to take iron out of hydrochloric acid solution and at the same time recover the hydrochloric acid. A double purpose is thus accomplished, saving useful materials in a form not too expensive to use over again and preventing harmful wastes from polluting water supplies.

Sulfuric acid, a commoner material than hydrochloric, for cleaning or "pickling" steel, is recovered by a different type of ion exchange resin in a process described to the meeting by A. M. Franklin and E. B. Tooper of the National Aluminate Corp., Chicago.

Metal finishing operations, especially chromium plating, also using ion exchange procedures, were described by R. F. Ledford and J. C. Hesler of the Industrial Filter and Pump Mfg. Co., Chicago. They discussed the cost of ion exchange treatments, with their refund in the shape of recovered metal, in comparison with other methods of waste disposal.

The carp, a native of Asia first introduced into the U. S. about 1830, is classed by scientists as belonging to the Minnow family.

Glass Cloth and Resins Are Heat Resistant

Laminated Plastic For Planes

A NEW PLASTIC for airplanes, that stands high temperatures better than aluminum and magnesium, was described at the recent meeting of the American Chemical Society.

The new material can withstand a temperature of 500° F. for eight days, declared Dr. William Cummings, a chemist of the United States Rubber Company's Naugatuck Chemical Division, Naugatuck, Conn. The plastic is a laminate made with glass cloth and three different resins, said Dr. Cummings, who is a senior group leader engaged in chemical research. Resins are the fluid substances from which certain plastics are formed.

Wide applications were foreseen by Dr. Cummings for this new plastic in airplanes, ducts for hot gases, and high temperature molds and dies.

Tests of the resistance to bending showed that the new plastic is 50 per cent stronger than the next best plastic of this type, a laminate containing two of the same resins. A resin mixture of maleic alkyd and TAC (triallyl cyanurate) produced a plastic that withstood a bending force of 19,000 pounds per square inch after it had been heated at 500° for eight days. The new laminate made from a mixture of these two resins plus DET (a diallyl bicycloheptene dicarboxylate), resisted a force of 30,200 pounds per square inch under the same conditions.

When only DET was added to the alkyd resin, the strength after heat treatment was 10,200 pounds per square inch, added Dr. Cummings. This value was below that obtained with TAC, yet the use of both DET and TAC gave a stronger plastic than did the use of either one alone with the alkyd. Moreover, the new material will cost less than the TAC plastic, he predicted.

The addition of DET to a resin mixture of TAC and alkyd resulted in a plastic less likely to get many fine cracks in its surface. This effect, known as "crazing," was least evident when a resin mixture of one part of TAC and one part of DET were added to two parts of alkyd, according to Dr. Cummings. A smaller proportion of DET permitted more crazing with a corresponding loss of strength, and great low-strength characteristics of the DET alone.

Other laminates using various resins known to reduce the crazing effect in TAC-alkyd plastics were tested, but none was found to have the heat-resistant properties of the DET mixture, he said. Marvin Botwich, also of the Naugatuck Division, was co-author of the report.

There are from 50,000 to 60,000 sawmills in the United States.

Wallboard has been developed from waste cedar wood.

Chemical Techniques Form Basis for Patents

Inventions in Chemical Fields

Copies of patents may be obtained from the Commissioner of Patents, Washington 25, D. C. for twenty-five cents each. Send money, money order or patent office coupon, but not stamps, and order by patent number.

Boring Supersonic Flame

➤ A TOOL that bores into mineral ores with a scorching, supersonic flame has been patented to help mining engineers speed up their search for ores vital to the nation's economy and defense.

Using kerosene and oxygen, the tool has a jet burner which spews out a 4,500-degree Fahrenheit blaze at speeds up to 10,000 feet a second. The flame chips away the ore to form the borehole.

The jet flame's velocity, higher than those now produced by similar tools, accelerates drilling. In tests, a nine-inch hole was pierced at the rate of 5.04 inches a minute in Minnesota taconite iron ore. Conventional tools would burn out a seven-inch hole in this kind of ore at the slower rate of about 2.4 inches a minute.

Inventors George H. Smith and William J. Mitchell, both of Kenmore, N. Y., attribute part of the tool's effectiveness to shock waves set up by the supersonic flame. The two men assigned their patent, No. 2,675,993, to Union Carbide and Carbon Corporation of New York.

Anti-H-Bomb Cloak

➤ A WHITE, fireproof cotton cloak has been invented and is designed to be carried during periods of national emergencies when the H-bomb might be dropped on American cities. The cloak would be easy to don and would completely swath the wearer to protect him from flash burns.

Inventors William B. Davidson of Lake Stevens, Willard A. Wyatt and Warren B. Williamson of Monroe, Wash., who received patent No. 2,676,319 on their garment, report that it could be easily carried—in contrast to present anti-heat garments that use asbestos or a bulky double-wall fabrication. It would be fireproofed with chlorides of antimony.

Raising Oil Well Output

➤ OIL WELL productivity can be "substantially increased" by applying pressure to the oil-bearing rocks and then by detonating an explosive charge.

According to Otto F. Ritzmann of Takoma Park, Md., who assigned patent No. 2,676,662 to the Gulf Oil Corporation, applying a static pressure to the oil-bearing formation enlarges incipient fractures and cracks in the rock. The explosive produces an instantaneous shock wave which further shatters the formation so the cracks do not seal when all pressure is removed. The newly opened fissures permit more oil to drain into the pool tapped by the well.

Steel Alloy For 1,500° Heat

➤A NEW high-temperature steel alloy has been invented for such things as jet planes and gas turbines where scorching heat and chemicals attack less hardy metals.

The alloy, which may help advance America's industrial and defense potential, is a combination of silicon, manganese, chromium, nickel, molybdenum, tungsten, titanium, carbon, sulfur and phosphorus.

Inventor Charles T. Evans Jr. of Delmont, Pa., who assigned patent No. 2,677,610 to the Universal-Cyclops Steel Corporation of Bridgeville, Pa., says that when his steel alloy is properly fabricated and treated, it can be forged, rolled or cast into desired shapes.

It also has a high temperature load-carrying ability through 1,500 degrees Fahrenheit, is suitable for low stress service through 1,800 degrees Fahrenheit, can be softened by rapid cooling from high temperatures, is readily machinable and resists surface oxidation through 1,800 degrees Fahrenheit.

Heat Storage Sink

➤ELECTRICITY might become even more imposing as a household heating "fuel" if owners of houses equipped with heat pumps could store heat during the times of day when electric demand is not at its peak.

The machine would squeeze heat from the cold outside air and deposit this heat in a sink containing a chemical that can take up heat and later release it. The system has been tried before, but sometimes the chemical will not crystallize properly to release large amounts of heat. Dr. Maria Telkes of Cambridge, Mass., provides a refrigeration system in her heat sink (patent No. 2,677,243) that keeps a small amount of the chemicals crystallized so the rest will crystallize promptly upon demand.

Molybdenum Alloys

➤NEW ALLOYS of molybdenum with five other elements have been patented. The five new alloys will withstand chemical attack at scorching heats, thus can be used in gas turbine blades and elsewhere where hardness and strength at high temperatures are required.

The five main metals to be alloyed with molybdenum are vanadium, titanium, tantalum, zirconium and columbium. Also included in each of these alloys are small amounts of aluminum. Secret of the five molybdenum-based alloys is the very low carbon and oxygen content that allows the materials to be hot-worked, at temperatures up to 2,200 degrees Fahrenheit.

Patents number 2,678,268 through 2,678,272 were assigned to Climax Molybdenum Company, New York, for the five alloys, devised by John L. Ham of Dearborn, Mich., Frederick P. Bens and Alvin J. Herzig of Detroit, and George A. Timmons of Ferndale, Mich.

Easy Detection of Cyanide

➤ASSIGNED to the government is patent number 2,678,260, a method for detecting cyanide that can be used in the field by untrained persons. It was devised by Melvin M. Falkof, U. S. Army, and Benjamin Witten and Bernard Gehauf, Baltimore.

The new method, its inventors claim, is more sensitive than previous ones. To test for hydrogen cyanide in air, one end of a strip of filter paper is spotted with a chloramine solution.

The other end is moistened with a mixture of pyridine or one of its derivatives and a suitable pyrazolone.

The filter paper is then folded so that the two spots are close together. A blue color will appear on the pyridine-pyrazolone spot if the deadly hydrogen cyanide is present.

Brightening Aluminum

➤ A COMMON chemical made from sand has been found to cut costs in brightening the aluminum that goes into pots, pans and airplanes.

Silicic acid, when added to common aluminum-brightening baths of water, phosphoric acid and nitric acid, keeps the solution strong and active. Without it, the solution soon becomes exhausted because aluminum salts build up in the bath, and the nitric acid deteriorates.

Roy C. Spooner of Kingston, Ont., Canada, who assigned patent No. 2,678,875 to Aluminum Laboratories Ltd., Montreal, found that silicic acid increases the life of the bath by slowing down the rate of its attack on the aluminum being brightened. It also causes the surface to become shiny with less metal loss.

Aluminum articles can be brightened in as little as 30 seconds, but two minutes is a more average figure. Only five to 50 grams of silicic acid per liter of bath solution are required to do the job.

Waterproof Leather Shoes

➤ WATERPROOF leather shoes soon may relegate cumbersome rubber overshoes to your attic where you store your beaver-hat and hoop-skirt heirlooms.

A way has been found to waterproof leather with a siloxane—a chemical famous for its water-repellent nature. The chemical can be swabbed on the leather and will not clog its pores or make shoes hard to shine.

The patent, No. 2,678,893, was assigned to Dow Corning Corporation by Toivo A. Kauppi of Midland, Mich.

Snowmaker For Ski Resorts

➤ OWNERS and patrons of winter resort businesses some day may be completely independent of the weatherman for fluffy snow blankets on ski trails.

When winter comes but snow does not fall, the owner may turn on the snow-making machine which won patent No. 2,676,471 for Wayne M. Pierce Jr. of Milford, Conn. He assigned it to the Tey Manufacturing Corporation, also of Milford.

Fine mists of water are blown through a battery of ski-mounted jets with compressed air. As the compressed air expands, it becomes cold and helps to crystallize the water droplets into snowflakes. When the outdoor humidity is high, the result is best of all.

One object of the invention is to make such man-made snow economically feasible, Mr. Pierce says. In actual tests, the product proved to be superior to sand, cracked ice, straw and pine needles, all of which have been tried out as emergency substitutes during winters when snowfalls were lean.

Mr. Pierce's system consists of two pipes running side-by-side along the edge of the ski trail. One pipe contains water under pressure. The other contains compressed air. Both pipes are equipped with regularly spaced valves to which the snow-making nozzles are attached. The valves can be regulated to yield snow of various textures.

Book Condensations

MODERN CHEMISTRY — Charles E. Dull, William O. Brooks, and H. Clark Metcalfe—*Holt*, 587 p., illus., $3.88. A high-school textbook originally written by the late Charles E. Dull, but now completely re-written and revised to incorporate modern developments and with certain parts marked for better students.

PRODUCTION OF NATURAL GAS SUBSTITUTES BY PRESSURE HYDROGASIFICATION OF OILS—H. R. Linden, J. J. Guyer and E. S. Pettyjohn—*Institute of Gas Technology*, Interim report sponsored by the Gas Production Research Committee, 35 p.,illus., paper, $2.50. In laboratory tests and in pilot plant tests, it has been possible to attain complete gasification of light distillates to make a substitute for natural gas.

NEW FIBERS FROM PROTEINS—Robert Louis Wormell—*Academic*, 208 p., illus., $5.80. Putting forth a generalization of the "corpuscular theory" which, it is believed, may remove some of the confusion on the behavior of protein fibers.

CHEMICAL PATHWAYS OF METABOLISM, Volume I—David M. Greenberg, Ed.—*Academic*, 460 p., illus., $11.00. A survey of existing knowledge of the metabolism of major constituents of living organisms. Each chapter is by an individual actively working in the field.

INTRODUCTION TO STATISTICAL THERMODYNAMICS—Malcolm Dole—*Prentice-Hall*, 250 p., illus., $6.25. A text on a subject that, the author says, bridges the gap between thermodynamics and kinetics on the one hand and between chemistry and physics on the other.

GENERAL COLLEGE CHEMISTRY—Andrew J. Craclett and Jose Gomez-Ibanez—*Holt*, 642 p., illus., $6.00. A first-year college text.

GENERAL CHEMISTRY — P. W. Solwood—*Holt*, rev. ed., 657 p., illus., $6.00. For the student whose major interest may or may not be in chemistry.

PESTICIDE HANDBOOK 1954—Donald E. H. Frear, M. Frances Sunday and Sidney Friedman — *College Science Publishers*, 6th ed., 196 p., paper, $1.25, cloth $3.00. This completely revised edition lists 5,763 products and tells about their chemical composition, compatibilities and hazards.

THE SULPHUR DATA BOOK—William N. Tuller, Ed.—*McGraw-Hill*, 143 p., $5.00. A reference book of data on the characteristics and processing of sulfur prepared for engineers, chemists and students.

CRYSTAL DATA: Classification of Substances by Space Groups and Their Identification From Cell Dimensions —J. D. H. Donnay and Werner Nowacki with the collaboration of Gabrielle Donnay—*Geological Society of America* Memoir 60, 719 p., $5.00. The main table shows the distribution of about 3800 different compounds among the space groups. A formula index and a name index are included.

SILAGE FERMENTATION — A. J. G. Barnett — *Academic*, 208 p., illus., $5.00. A discussion largely concerned with grass and what happens to it under fermentation.

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➤ A MASS SPECTROMETER designed for sensitivity and accuracy, yet compact and easily transportable, is offered for high speed analysis of gaseous and light liquid mixtures. Its cycloidal focusing of ions depends upon ion mass and the strength of crossed uniform electric and magnetic fields. This Cycloidal Spectrometer is being introduced by the Consolidated Engineering Corporation, Pasadena, California, at a price slightly in excess of $11,000.

➤ FLUOROSCOPY and radiography used in inspection of mass-produced objects made of light metal, rubber, plastics, porcelain and glass is aided by the new Norelco MG 60 Industrial X-ray Unit, offered by the Research and Control Instruments Division of North American Philips Co., Mount Vernon, N. Y.

➤ A COMPREHENSIVE chart showing chemical methods for converting acrylonitrile into more than 100 derivatives is available from Monsanto Chemical Company.

The 44-by-34-inch wall chart presents in sequential form the methods for the synthesis of acrylonitrile compounds according to three general classifications: Cyanoethylation reactions, nitrile reactions and olefinic reactions.

In addition, the chart contains a literature summary of potential uses for 16 of the more important acrylonitrile derivatives. Material for the chart was compiled by scientists of the Monsanto laboratories at Texas City, Tex., where acrylonitrile is manufactured.

For further information contact Public Relations, Monsanto Chemical Company, St. Louis 4, Mo.

➤ HIGH-TEMPERATURE conditions requiring a precision electric switch are those for which Minneapolis-Honeywell designed the new Micro Switch. It is offered for vulcanizing plants and others where the temperature range is between minus 50 deg. and 1,000 deg. F. Designated as IHTI, the device is manufactured and sold by Micro Switch, Freeport, Ill.

➤ STRIPPER for Epoxy type enamels which is used at room temperature loosens the enamel by wrinkling action so that it may be rinsed off with water. Known as Enthone Stripper S-18, it is a clear, thin liquid, nonflammable, mild in odor, pleasant to use. It is manufactured and sold by Enthone, Inc., 442 Elm St., New Haven, Conn.

➤ DIFFRACTION gratings manufactured by Bausch & Lomb are fully described in Booklet D-261, illustrated with photographs and diagrams, written and edited by David Richardson, head of the company's spectrographic research. Technical details, including sources of error, are discussed in this useful bulletin, which may be obtained from Bausch & Lomb Optical Co., 635 St. Paul St., Rochester 2, N. Y.

➤ A CATALYTIC muffler for diesel engines has been developed and named the Dieseler by Oxy-Catalyst, Inc., of Wayne, Pa. The device operates with the type of catalyst produced by Eugene J. Houdry. It is designed to get rid of the unpleasant exhaust gases from diesel-powered industrial equipment in mines and other close places.

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